Confererence and Trainning School

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SUSTAINABLE RETROFITTING SOLUTIONS FOR PRECAST CONCRETE REZIDENTIAL BUILDINGS

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The current context:

▪Current energy policy and climate mitigation goals require distinct reductions of the primary energy demand and greenhouse gas emissions in the building sector.

The existing building stock poses a special challenge since it proves very difficult to activate the large existing reduction potentials because of a variety of institutional, economic, informational and social reasons. Clear-cut technically and economically optimized retrofit strategies and policy instruments for different types of existing buildings are not established yet for the relevant actors nor for public authorities designing policy instruments and subsidy programmes**.**

•In the present context, the Romanian population, as like that of Eastern Europe, lives in collective residential buildings with concrete structure and large prefabricated panels, built from 1953 to 1989, in a percentage of 25% to 45%.

•There is a need for guidelines and standardized approaches for different building types aiming at reducing the complexity which arises from the vast built space.

Such guidelines and approaches ease the diffusion of new approaches and technologies as they lower costs as well as technological and economic risks.

Most of these rise some issues concerning their conformity to the quality requirements:

e-thermic and waterproof insulation and energy economy;
f-protection against noise;
and some of these (mostly those built before the ‘70) rise problems regarding:
a-strength and stability;
b-safety in exploitation,but also problems concerning aestethics and interior space segmentation
c- fire safety

The current context:

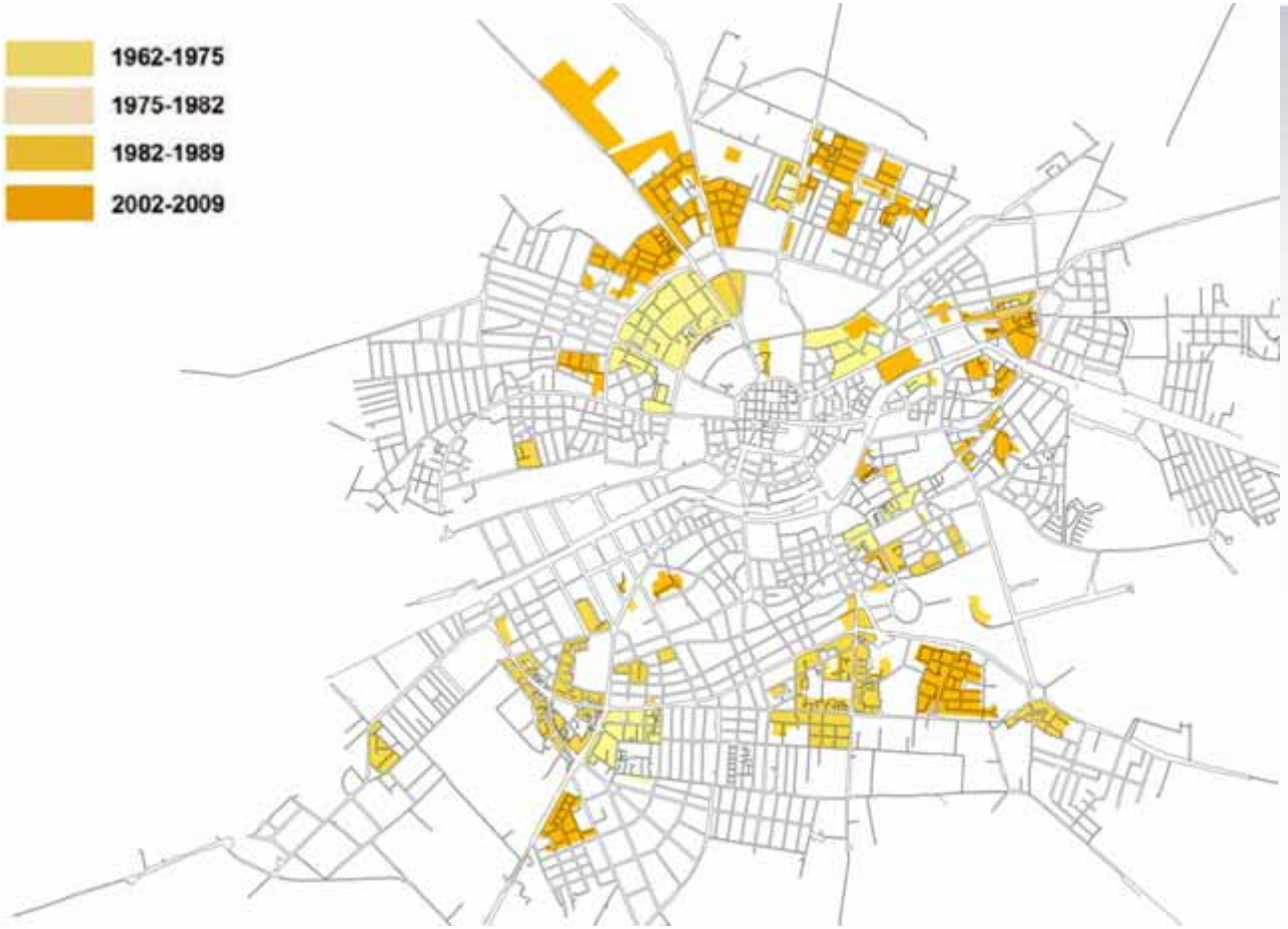
INSPIRE - Integrated Strategies and Policy Instruments for Retrofitting buildings to reduce primary energy use and GHG emissions

WP2 - Case studies on sustainable renovation in Eastern and Northern Europe

2011	**Stage I: 30.07.2011**
	Activity I.1 Identification of existing types if prefabricated concrete residential buildings (UPT)
	Activity I.2 Design in Romania. Evolution of codes (UPT)
	Activity I.3 Retrofitting techniques. Finland's experience (VTT)
	Stage II: 15.12.2011
	Activity II.1 State-of-art on retrofitting technologies of prefabricated concrete residential buildings (UPT)
	Activity II.2 The market of buildings' rehabilitation in Romania (UPT)
	Activity II.3 Experimental research program – Preliminary evaluation

Statistical data on the existing building stock in Romania:

Statistical data on the existing building stock in Timisoara:



LIVING TYPOLOGY

The urban area of Timisoara is divided into 10 districts with a total of 21.837 buildings of different types:

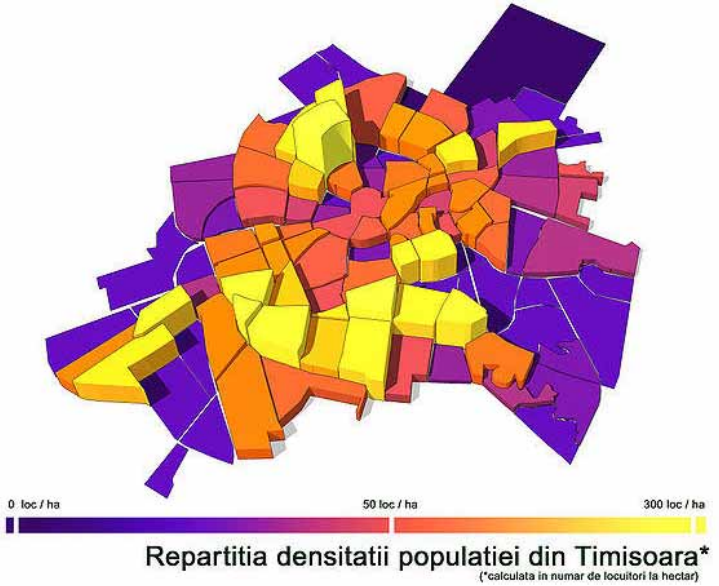
- individual buildings (15.039)

- multiple flats(3.639), having a height regime of 1 to 3 stories;

- colective buildings 5 to 11 stories.

The living field accommodate 122.195 flats, with a combined livable surface of 4.372.696 mp and 277.944 rooms.

From the total of flats, 71,3% are colective buildings, 28,7% are individual buildings.



Study on the existing building stock in Timisoara:

Prefabricated concrete residential buildings, ('the concrete blocks') present major difference between typologies according to few basic criteria:

***urban:**

- density (number of units/ha);
- related communitarian functions (schools, shopping centers, green spaces);
- height (number of storeys)
- accessibility (type of roads, parking areas, distance from these to the housing);

***architectural:**

- surface' (square metres built, inhabitable area, usable area) along with the government decretes modifications from that time;
- built space, the facades' plastic, space configuration, access definition

*** energy consumption and CO_2 emission:**

- because of the differences between the finish of prefabricated panels; the difference of stratification of the closing panels and the slab;

*** finish :**

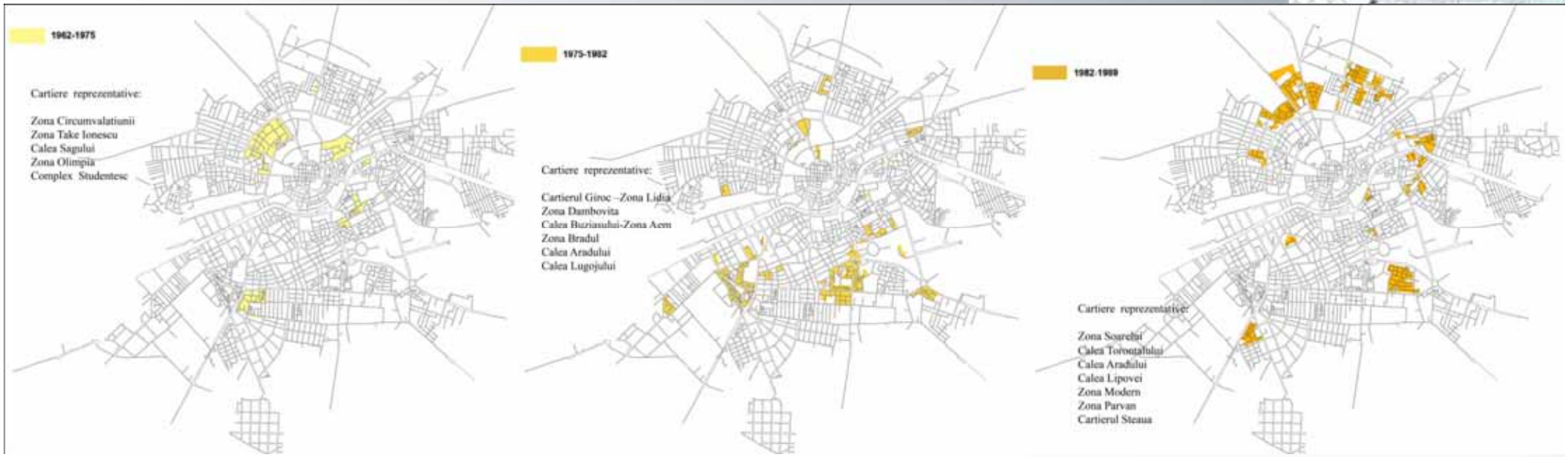
- (thermal insulation, waterproof insulation, noise insulation);

*** engineering :**

-(differences in seismic conformation according to the time when the housing units were executed)

the interior reduced surfaces of flats

Study on the existing building stock in Timisoara:



Studies show that buildings in Timisoara were made out of large prefabricated panels and were executed in 3 main stages using diferent tipologies of standard projects; conditioned by state decretes from that period and also because of the evolution in design development. From an urban stand point these 3 stages differ as folows:

1962-1975 - densification of 70 unit/10.000m^2; distance between units having approximatly 60 lm and affernt to those, multiple comunity buildings. Flats had relative small living areas.

1975-1982 - majore densification of approximatly 300 unit/10.000m^2; distance between units having approximatly 15 lm and no comunity buildings. Flats had relative small living areas and comercial areas were integrate on the first floor.

1982-1989 - densification of 80 unit/10.000m^2; distance between units having approximatly 40 lm and affernt to those, multiple comunity buildings

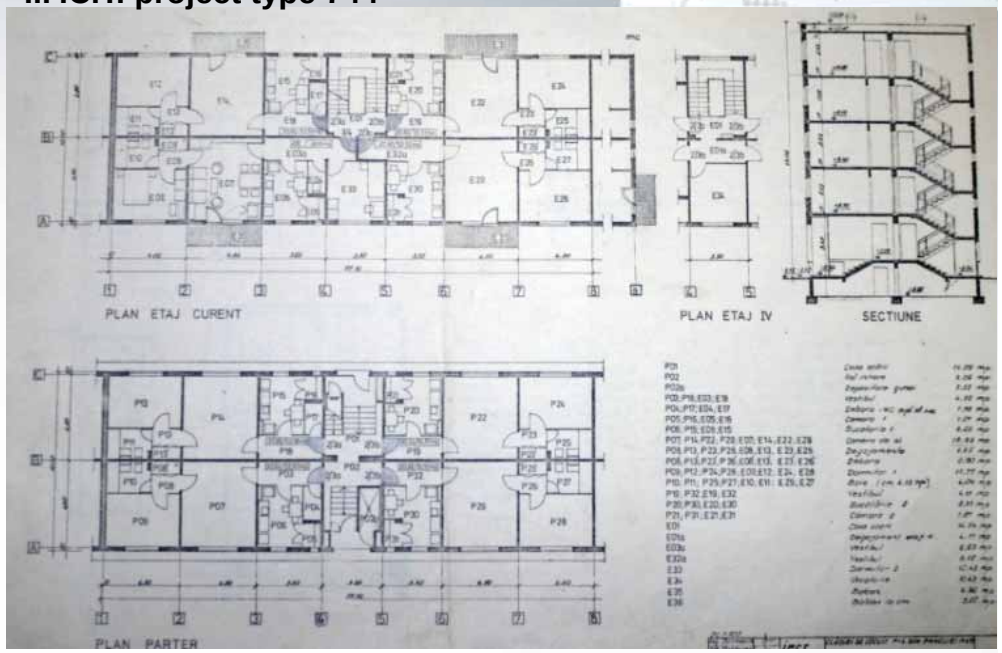
Study on the existing building stock in Timisoara:

In Timisoara 3 types of standard projects in heigh frequency use have been identified :

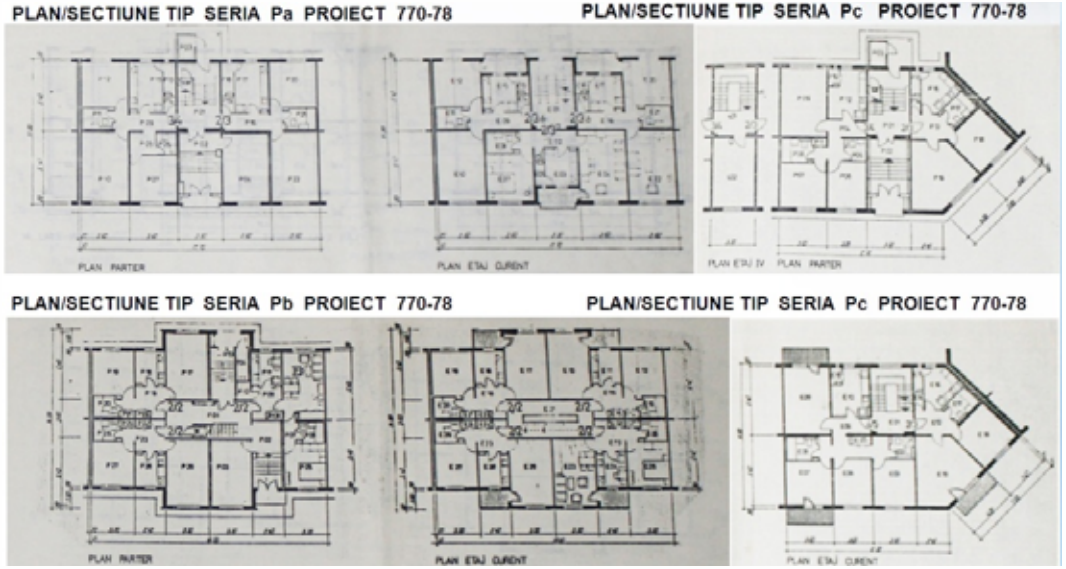
-**I.P.C.T. project type 744 used between 1962-1975**
-**I.P.C.T. project type 770 used between 1975-1982**
-**I.P.C.T. project type 1340 used between 1975-1982**

At the basis of the 770 project realized in 1978 there were 3 major typologies (series) each of them being and having the cross-sections(Pa1--Pa4; Pb1--Pb4) assembled in 5 known ways to realize an assembly In sections(middle- middle, point-middle,middle-point,middle-end).The 3 project series (Pa; Pb;Pc) have different characteristics regarding orientation, accessibility,position of vertical circulation,layout dimension,etc. Pa and Pc series have double orientation while Pb serie was realized with a simple orientation**. Seriile** Pc Pc series are especialy made to connect L or U sections,these serie being used in various combinations with other series.These are used mostly to solve straight or splay angles.

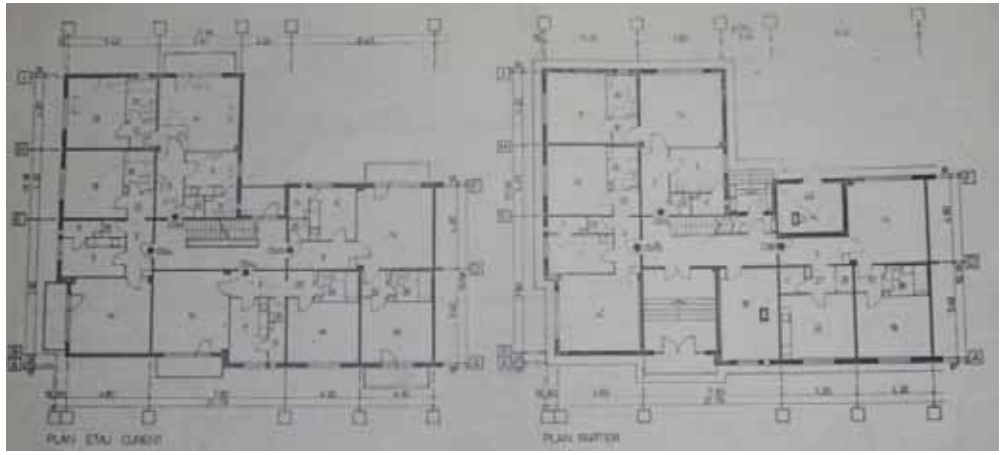
I.P.C.T. project type 744



I.P.C.T. project type 770



I.P.C.T. project type 1340



Residential areas - CURRENT STATUS

Urban major disfunctionalities:

-Lack of green spaces and parking

-lack of concern for the maintenance of overall building - facades, cornices, balconies

- non-unitary rehabilitation interventions (the attic) of the assemblies

- abusive extensions of buildings at ground level

Residential areas - CURRENT STATUS











Urban major disfunctionalities:

-mix of collective housing and individual homes, placed at a relatively short distance
-Lack of green spaces and parking
-lack of concern for the maintenance of overall building - facades, cornices, balconies
- non-unitary rehabilitation interventions (the attic) of the assemblies

Residential areas - CURRENT STATUS













Urban major disfunctionalities:

-Lack of green spaces and parking
-lack of concern for the maintenance of overall building - facades, cornices, balconies
- non-unitary rehabilitation interventions (the attic) of the assemblies
- abusive extensions of buildings at ground level

Residential areas - CURRENT STATUS










The main negative aspects found :

▪existence of inadequate living spaces (basements, homes with annexes used in common);

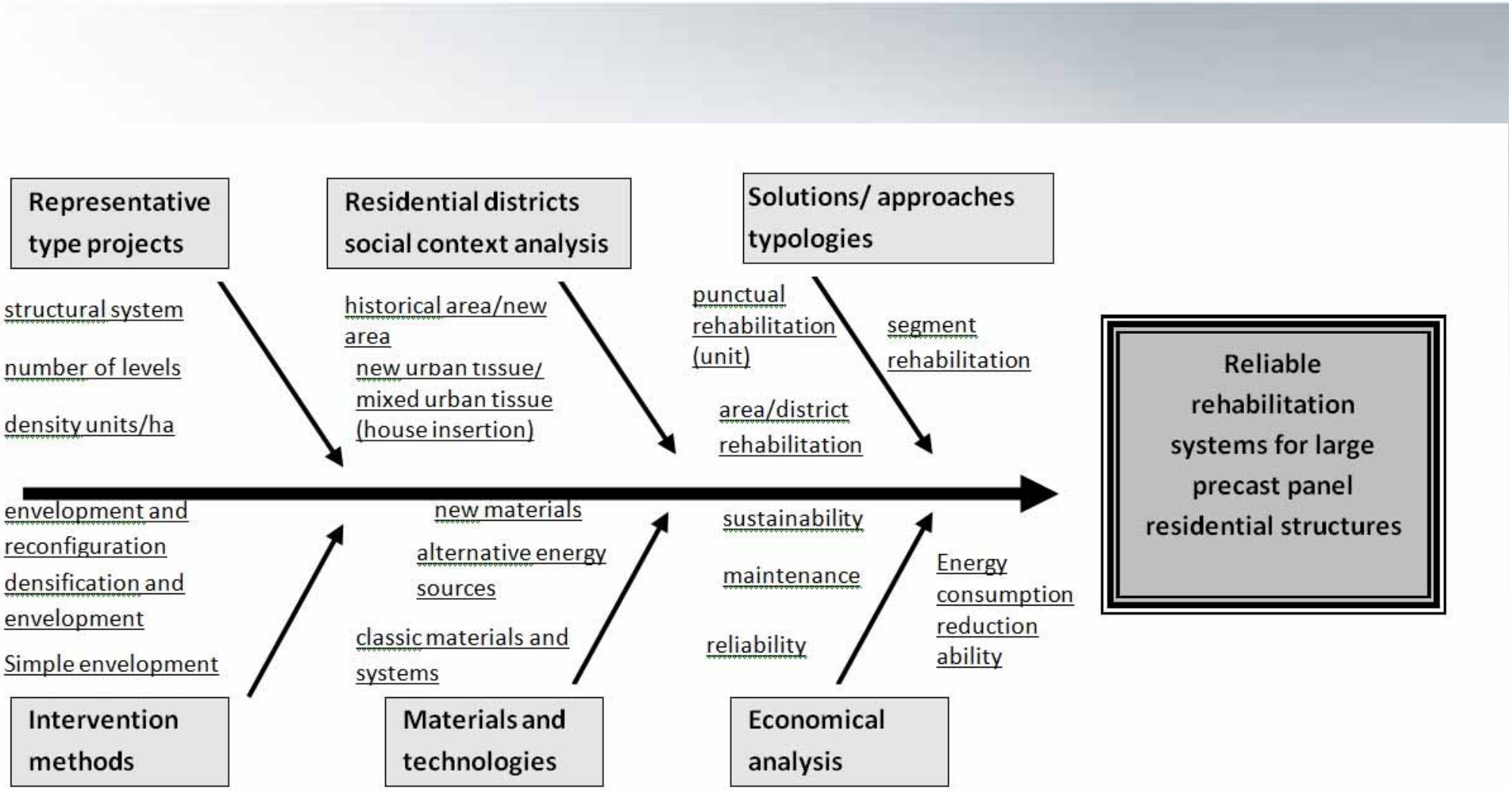
underdimmensionnement of interior space (number of bedrooms and living area) and poor division of interior space, high maintenance costs;

•poor thermal and noise insulation ;

•the poor condition of public utility plant;

•Underdimmension or nonexistent external spaces for residential areas (household platforms, green spaces, children's playgrounds, parking lots;

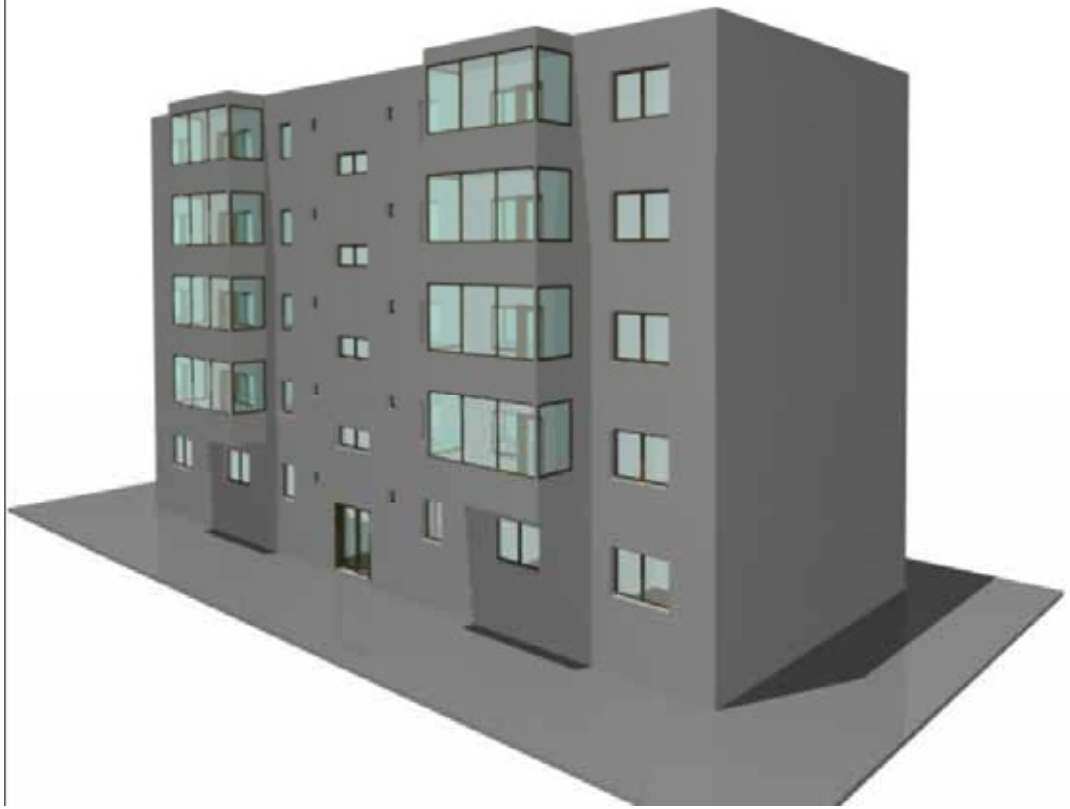
The proposed intervention method for the building stock:



Interventions on apartments by redesigning the interior areas:

During the period 75 to 82 a significant increase of the average inhabitable area per apartment was made, namely 33 square meters from 27 square meters. The inhabitable areas in the units built before 1975, are fairly severe and, in addition, are built using the same rigid compartimentation system.They require a special attention in the reorganization of the interior spaces.

I.P.C.T. project type 744 used between <u>1962-1975</u>



Existing walls are:
- structural, of diaphragm type, large precast concrete panels
- nonstructural for partitioning purposes.
Exterior walls are: tree layered, large precast concrete panels

A. Interventions on apartments by reconfiguring the areas delimited by vertical surfaces.

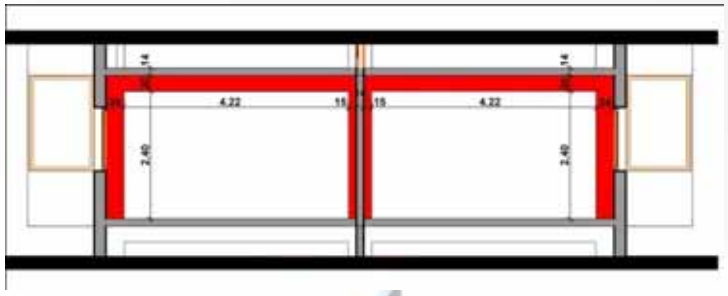
•repartitioning through redesign of interior spaces and conversion of nonstructural walls

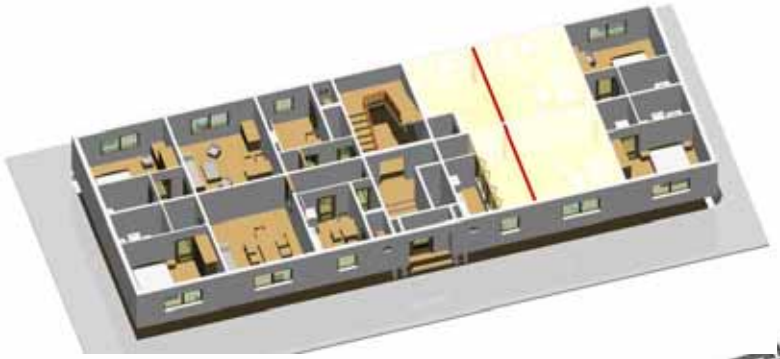
•reconfiguration through redesigning and extending the openings in the diaphragm walls;

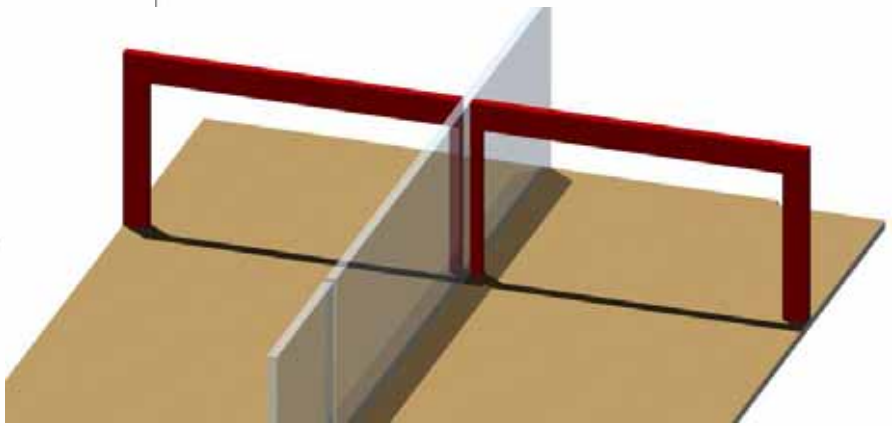
Developing optimal structural surface area for openings taking into account:

• the period in which the panels were realized (structural: reinforcement and seismic conformation)

• - building lifecycle and capacity to increase the confort of living

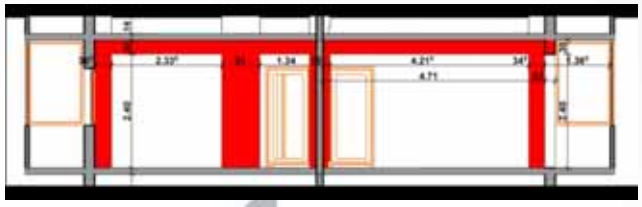


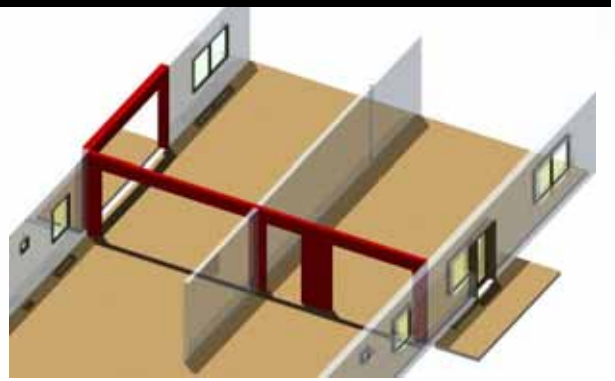




A. Interventions on apartments by reconfiguring the areas delimited by vertical surfaces.

- repartitioning through redesign of interior spaces and conversion of nonstructural walls
- reconfiguration through redesigning and extending the openings in the diaphragm walls;
- extention of the flats through an eficient thermal closing of existing balconies.





C. Existing flats expanding through vertical unification.

•The pairing of two apartments occurring at different storey and turning them into one apartment by creating interior stairs and generous living rooms.
This operation can be considered one of the most spectacular methods for creating flats with ample living and with height variation and diverse volumetric design.

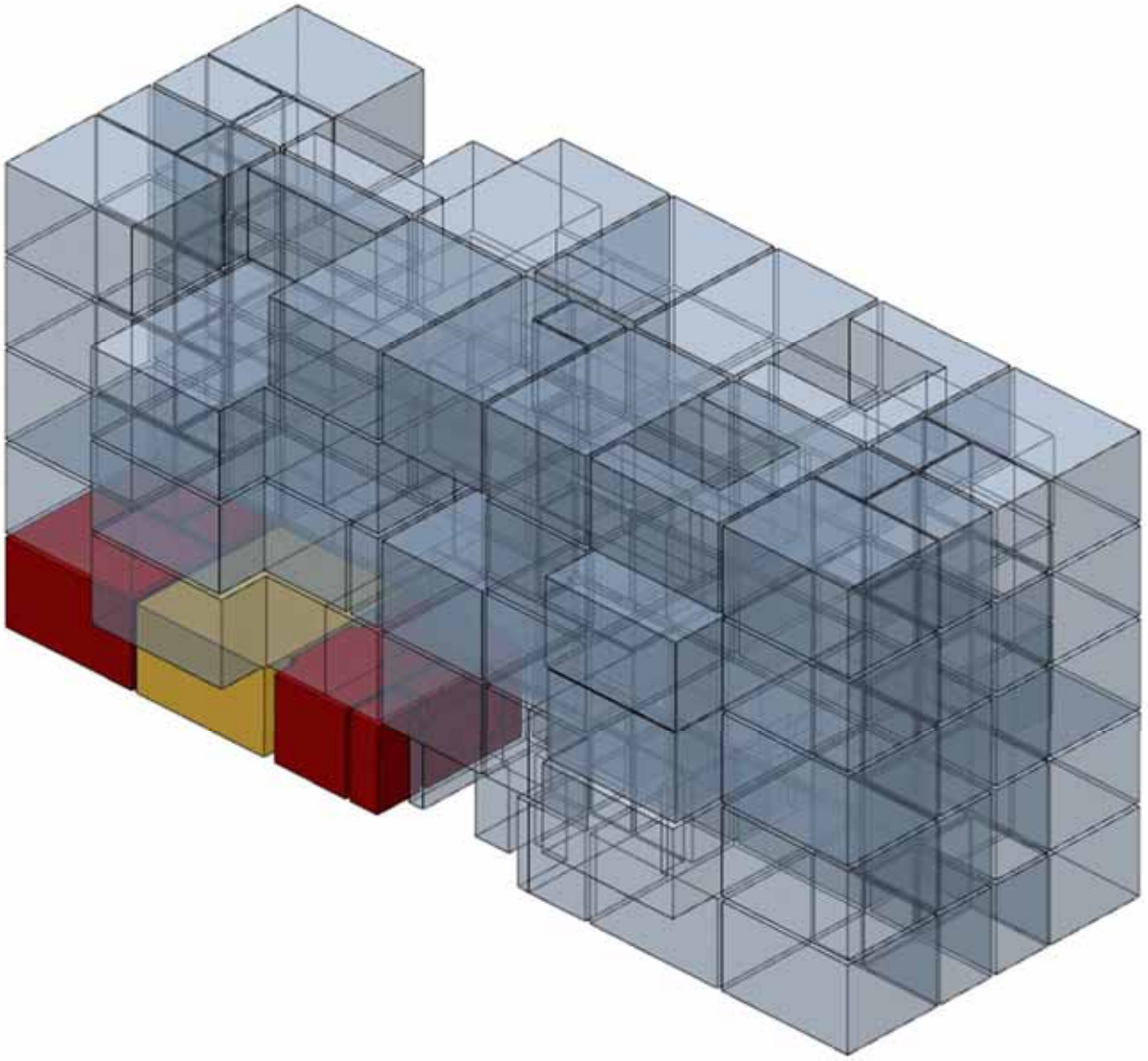
•creating spaces with different interior height
•creating flats with ample living areas and increased comfort .

• This kind of intervention needs to be done carefully because it imposes reorganization of interior areas through major interventions both on vertical structural diaphragm walls as well as structural floors, especially taking in consideration the possibility to partially remove them or to operate upon them through large openings.

• In the same time this implies an urban decrease densification phenomenon.

C. Existing flats expanding through vertical unification.

Interventions on apartments by redesigning the interior areas:



<u>The goal of this particular research is:</u>

-to configure different types of flat reconfiguration, and to find possible ways of grouping them into the existing structure.

-to determine the main advantages of these matrix;

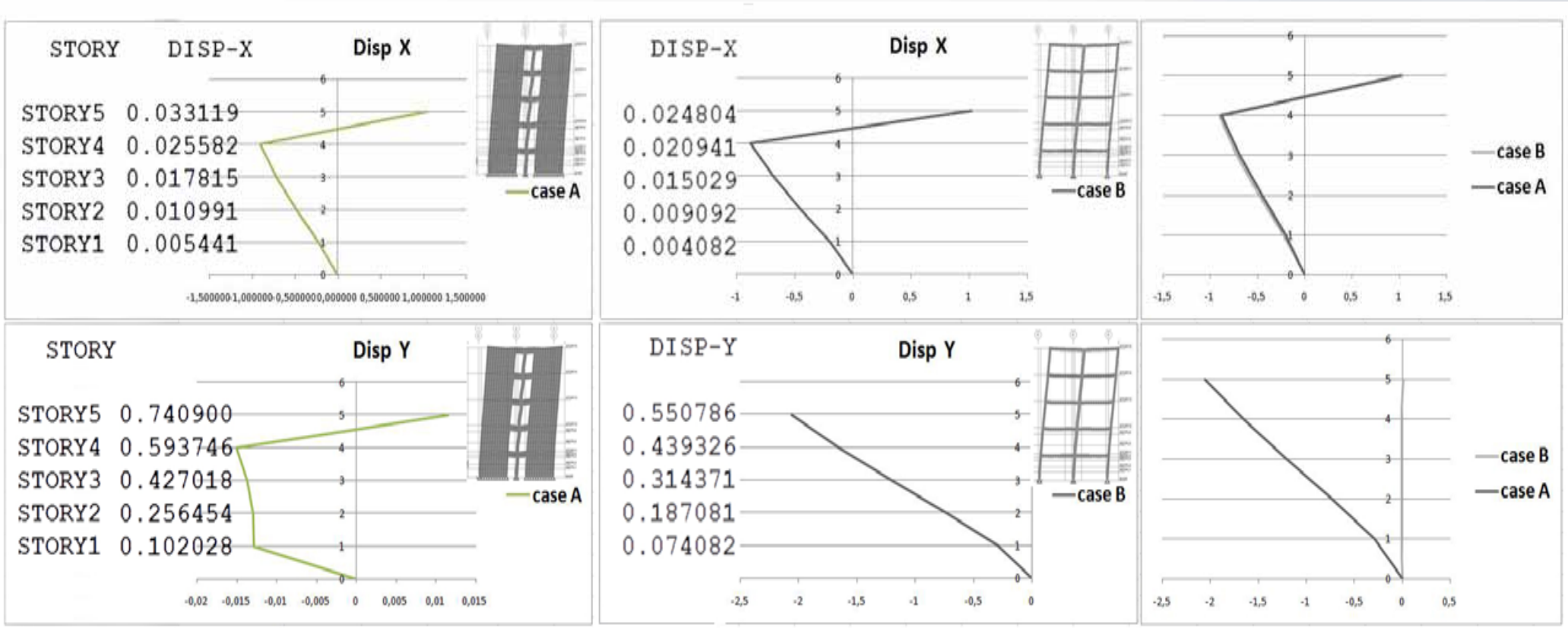
-to conform them to current codes;

Interventions on apartments by redesigning the interior areas:

STRUCTURAL BEHAVIOUR

ETABS 3D ANALYSIS

The 3D analysis was performed with ETABS program , using shell type finite elements. The method was used for the initial structure (case „A") and also for the structure in which large openings were performed in the vertical diaphragms in axes „C" and „F" (case „B")
The lateral displacements and drifts obtained confirmed that a higher displacement for the diaphragm in which the enlargement was done aren't recorded because the slabs are very rigid and serve to load distribution.

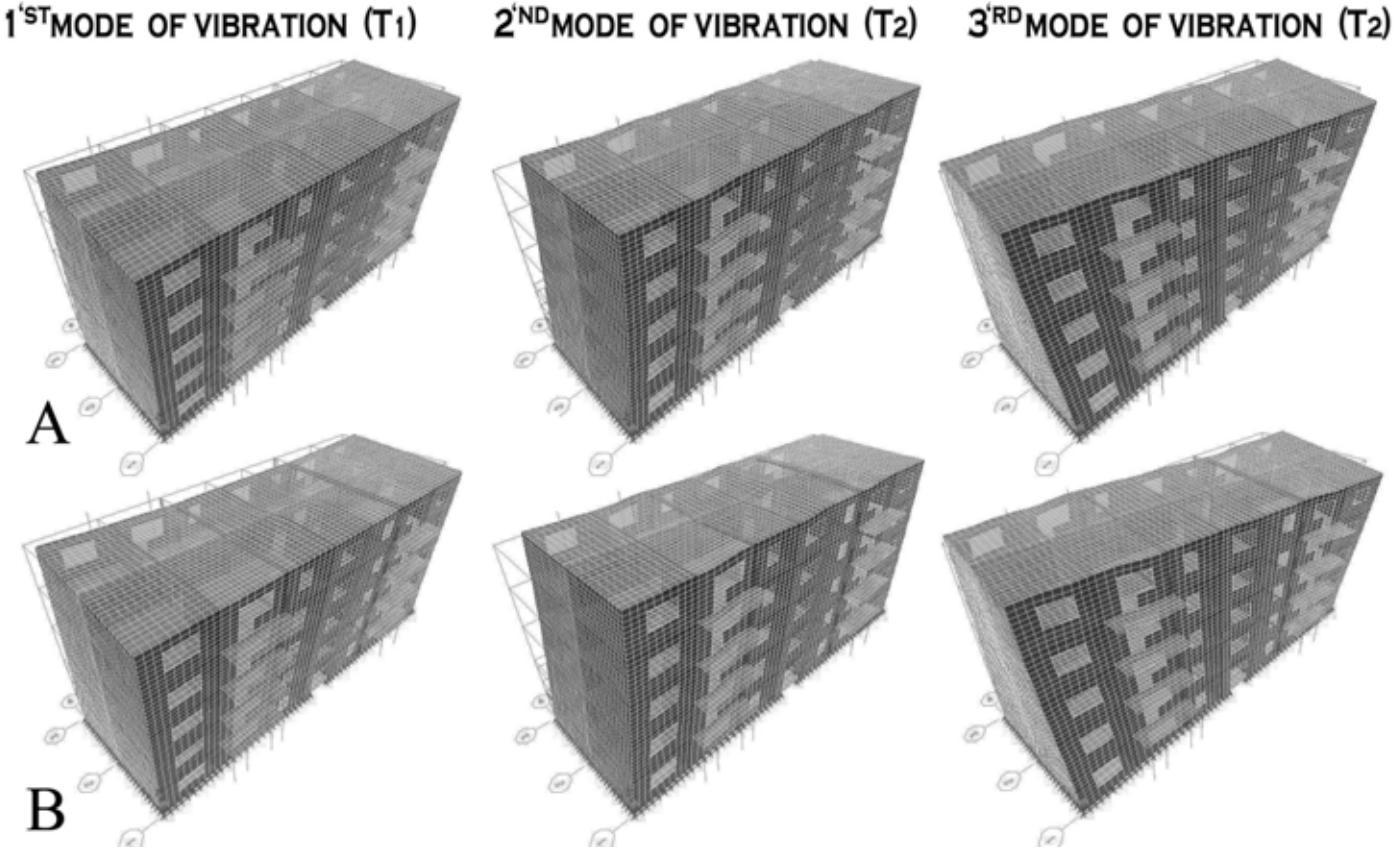


STRUCTURAL BEHAVIOUR

ETABS 3D ANALYSIS

The modes fields of vibration are similar,for both structures, the first mode is transversal, the second mode is longitudinal and the third one is torsional.

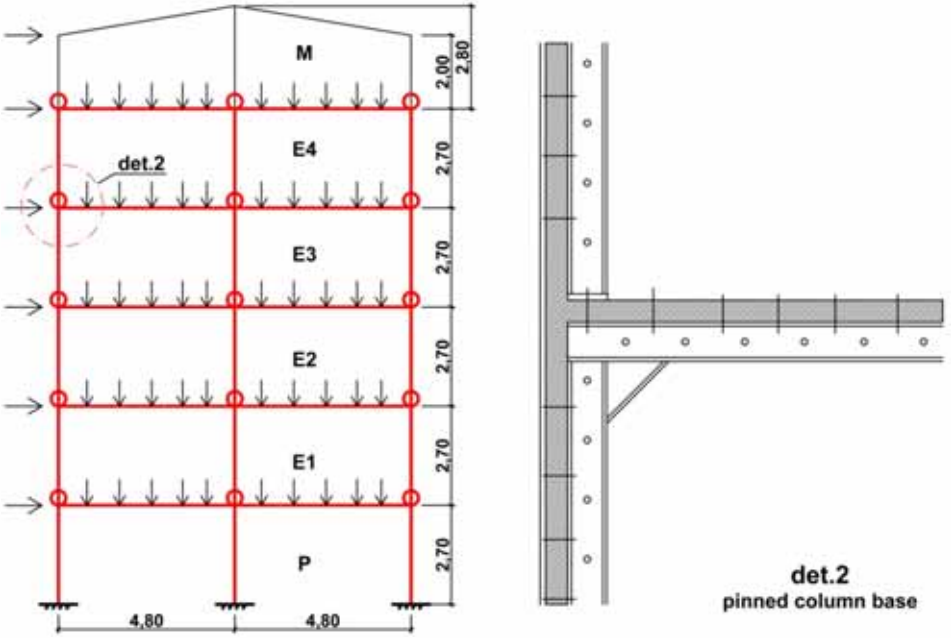
The normal stresses S_{11} and S_{22} for the seismic combination for case A and case B have aproximatively the same values. In the same time the stress redistribution due to the interventions brings changes in the stress diaphragm field.
The shear stresses S_{12} shows us that due to the redistribution, for case B these efforts have values 5 times bigger than for case A.
For the studied seismic level the stresses are in the design resistance limits.

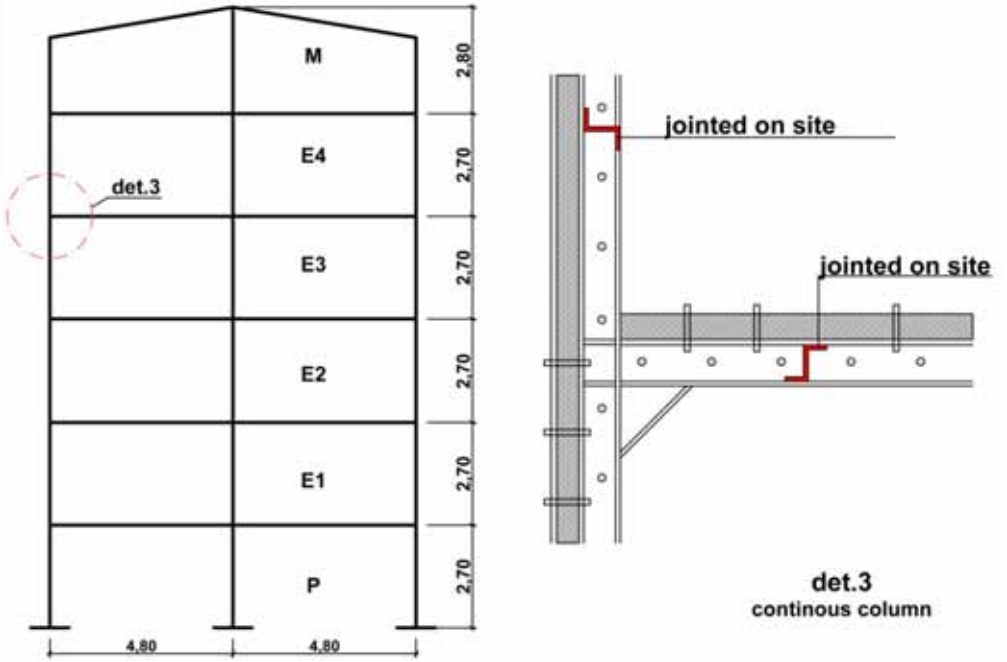


EIGEN PERIODS [s]			
case "A"	T_1	0,1003	Δy
	T_2	0,0815	Δx
	T_3	0,0741	θz
case "B"	T_1	0,1097	Δy
	T_2	0,0811	Δx
	T_3	0,0761	θz

For the case in which the same kinds of interventions are organized at all the levels of the construction and affect the same diaphragm, it is proposed to replace the reinforced concrete diaphragm with a mixed steel concrete frame.

The reinforced concrete diaphragm that is going to be weakened is strengthened with steel profiles, realized in steel construction shops, cast in sections, with a mass less than 200 kg, as jointed columns and beams. The sections are assembled on site by welding or with bolts.





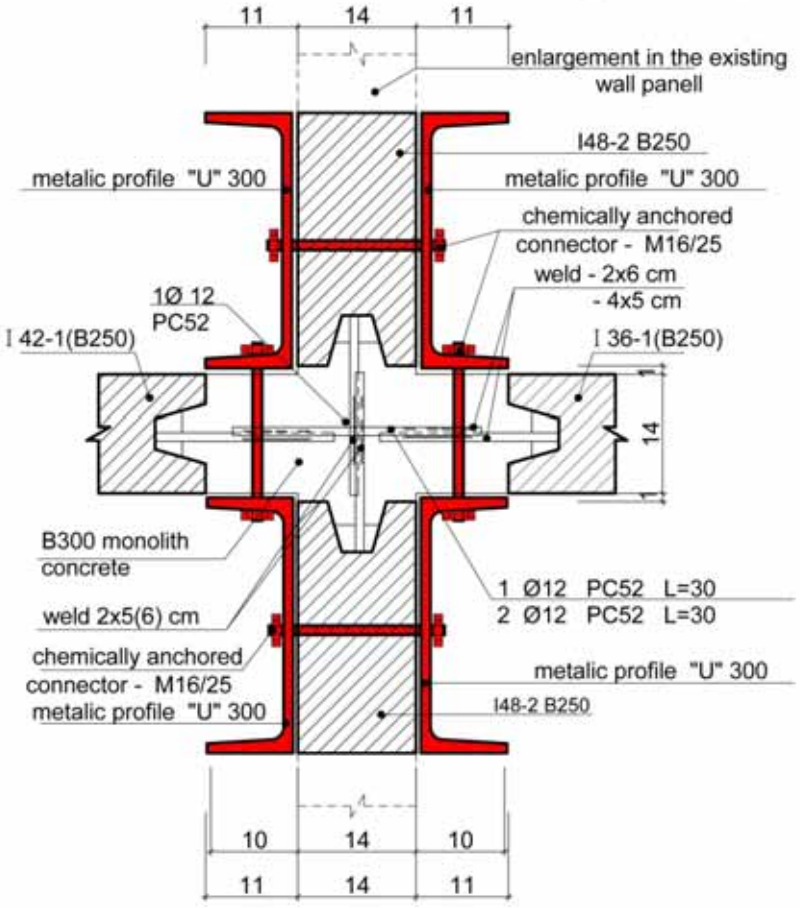
The columns of the frames have hinges above the slabs. In this case the pinned columns are made on a storey height and are jointed with the girder in the node, and at the base are jointed with the inferior slab and the inferior frame girder with bolts.

The steel columns can be made as a frame with rigid joints, when are jointed at about 1.0 meters above the slab, and at 0.2 from the joint of the girder. In all these cases, mixt steel reinforced concrete frames are capable to ensure the gravitational loads and to pass the loads to the infrastructure.

The solution improves the existing joints of large panels, and determines a compound effect of these structural elements with the transversal frame.

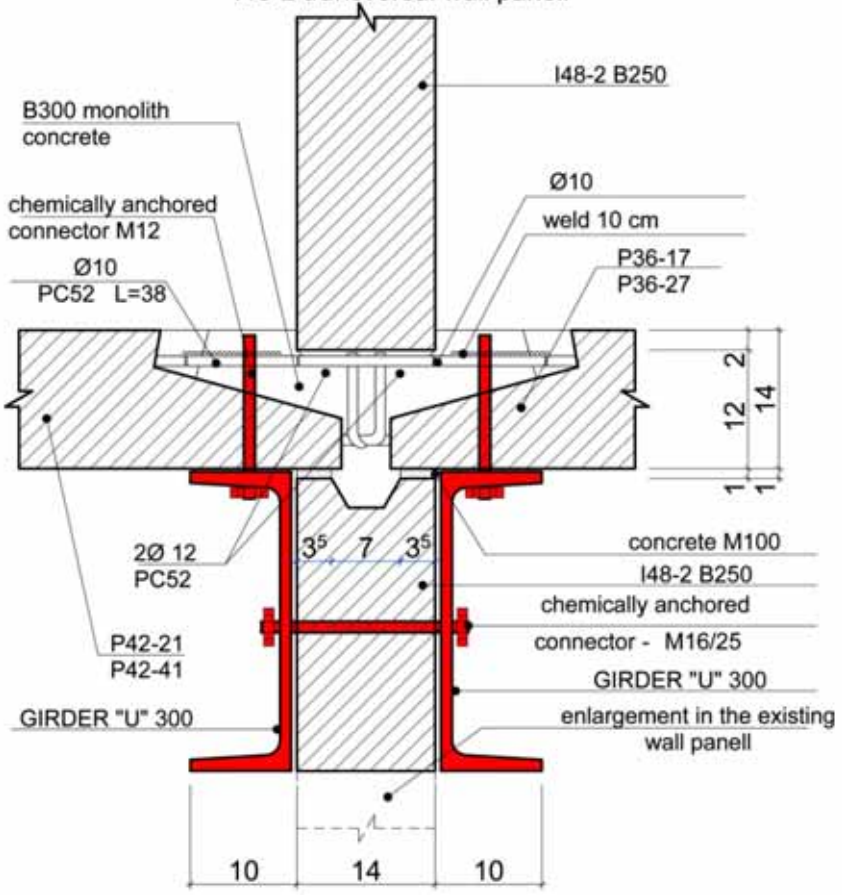
JOINT DETAIL INTERIOR WALL PANELLS INTERSECTION AND CENTRAL STEEL FRAME HORIZONTAL SECTION PROJECT Type T 744R

I48-2 transversal wall panel; I42-1 & I36-1 longitudinal wall panells

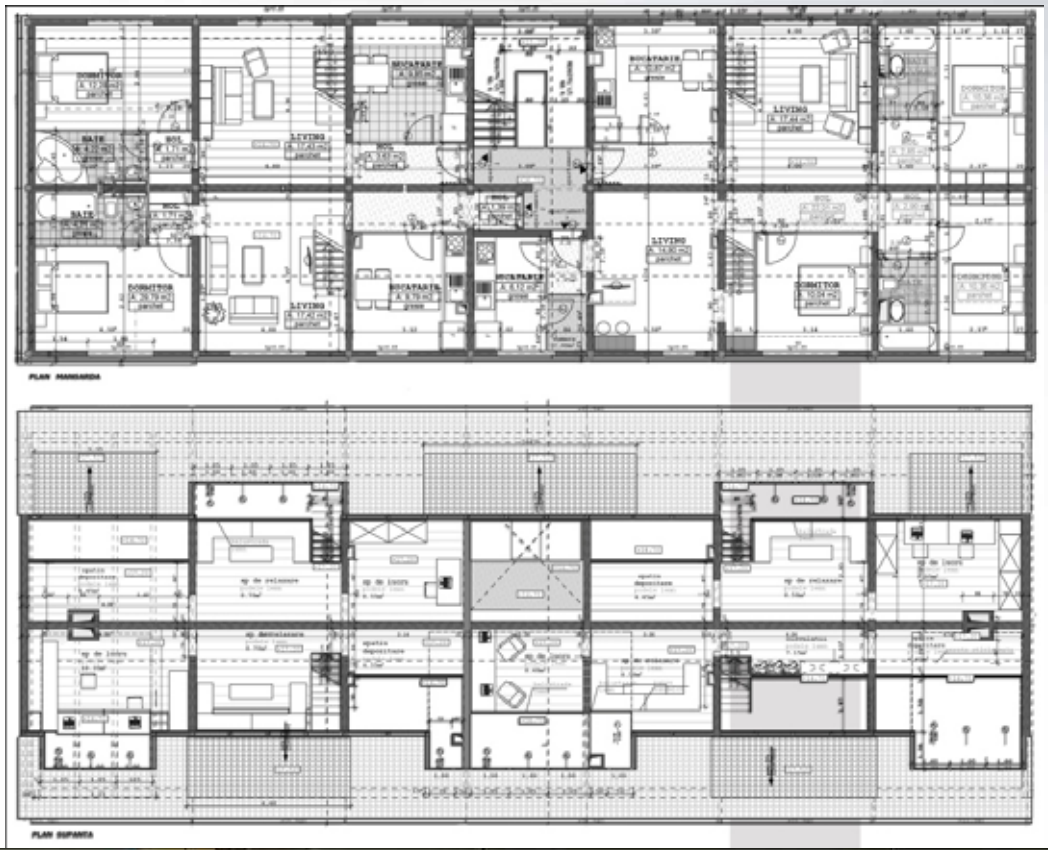


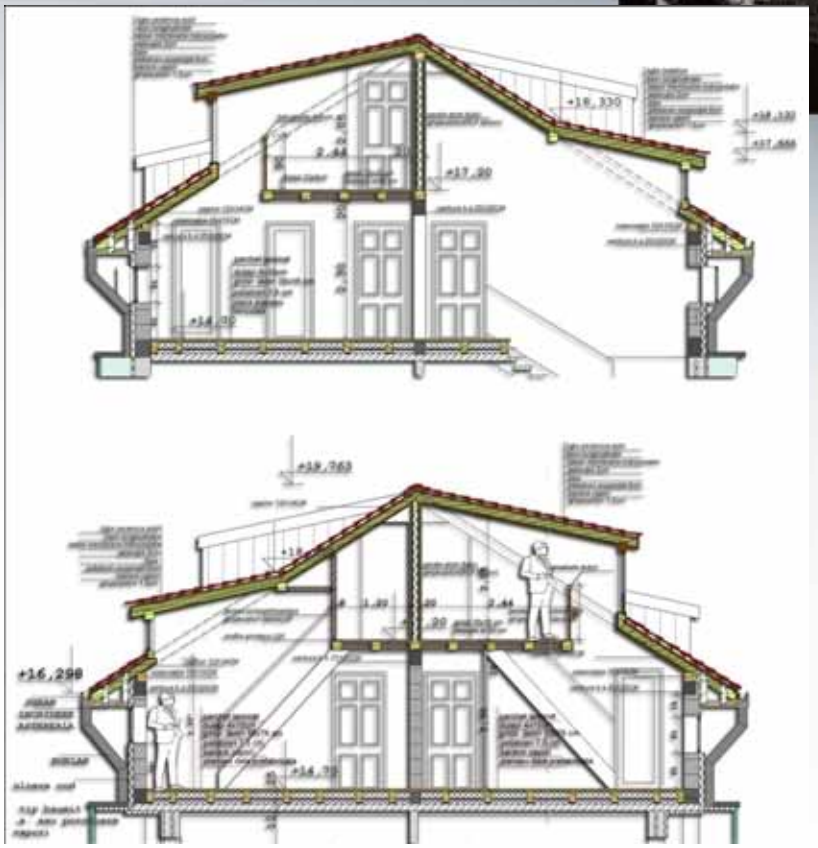
JOINT DETAIL AND GIRDER VERTICAL SECTION PROJECT Type T 744R

I48-2 transversal wall panell



Interventions on the attic areas:





LEGISLATION REGARDING FIRE SAFETY

Law no. 10-18 ian. 1995 – ''Regarding quality n construction''

Art. 5 – In order to obtain quality in construction it is mandatory to fulfill the following requirements:

a) resistance and stability
b) safety occupancy
c) fire safety
d) hygiene, people health, environment protection
e) insulation, waterproof and low cost
f) noise protection

Tabel 4.2.16.

Timpi de evacuare

Nr. crt.	Clădiri de locuit	Gradul de rezistență la foc	Timpul de evacuare (lungime maximă de evacuare)				Observații
			în două direcții diferite		într-o singură direcție (coridor înfundat)		
			secunde	metri	secunde	metri	
1.	Clădiri cu apartamente sau garsoniere, care nu sunt înalte sau foarte înalte	I şi II	125	50	63	25	Distanțele în interiorul apartamentelor de locuit nu se limitează
		III şi IV	63	25	30	12	
		V	30	12	20	8	
2.	Clădiri înalte şi foarte înalte	I	50 (88)	20 (35)	5 (38)	10 (15)	Valoarea din paranteze se referă la clădiri cu înălțimea mai mică de 50 metri

Tabel 4.2.3

Condiții pentru elementele de construcție

Nr.crt.	Denumire element	Condiții minime	Observații
1	Pereți despărțitori între clădiri, tronsoane şi apartamente	C0(CA1) 1 oră	In clădiri de gradul IV pot fi C2 (CA2b), iar în cele de gradul V pot fi C3 (CA2c).
2	Pereți despărțitori între băi şi bucătării, față de celelalte încăperi ale apartamentului în clădiri de gradul I - II.	C0(CA1) 15 minute	-
3	Pereți despărțitori între boxele gospodărești sau de depozitare din subsol sau demisol, în cadrul unor grupări de max. 300 m.	C4 (CA2d)	-
4	Pereți despărțitori între grupările de boxe gospodărești menționate la pct.3, precum şi între acestea şi spațiile tehnice ale clădirii	C0(CA1) 1 oră	Uşile spre coridoare vor fi rezistente la foc minimum 15 min.

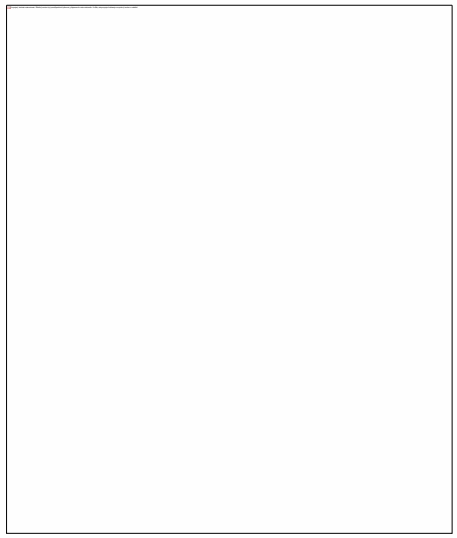
Fire protection for the new envelope – new materials and systems

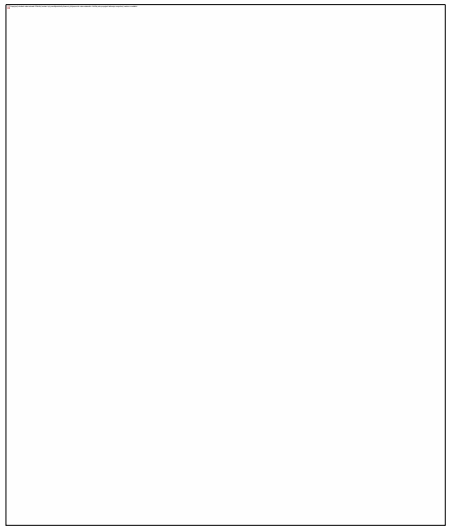
-HOW CAN WE DESIGN FACADES THAT PREVENT FIRE FROM SPREADING TO UPPER FLOURS

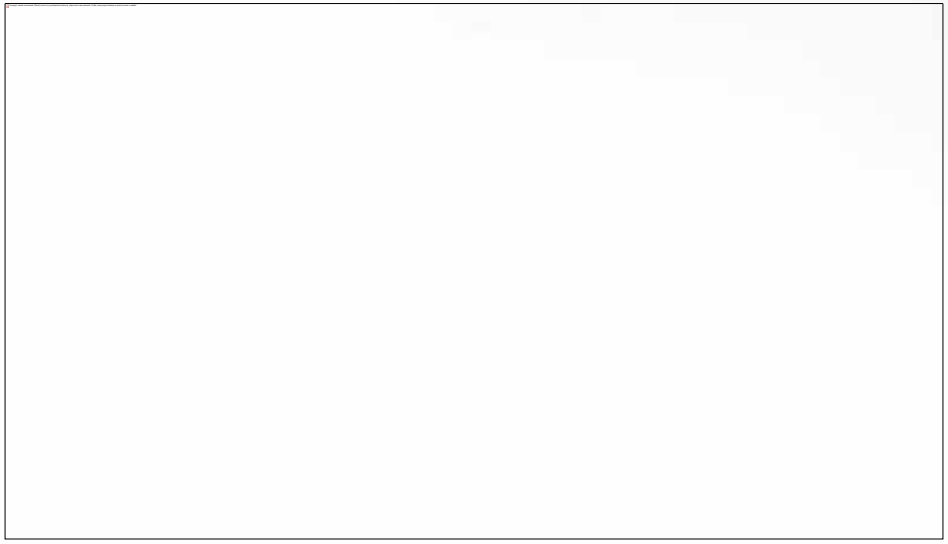
- WHAT MATERIALS TO USE – MATERIALS THAT DO NOT BURN OR MAINTAIN FIRE

- HOW TO INTEGRATE NEW SYSTEMS IN THE DESIGN OF URBAN FACADES

- SHOULD THIS BECAME IMPORTANT IN RETROFITTING DESIGN







Fire based design for balcony enclosure new materials and engineering solutions

-AS CURRENT FACT IS THAT THE OCUPANTS /LANDLORDS TEND TO ENCLOSETHEIR BALCONIES AND TO ENLARGE/DEMOLISH THE EXISTENT WALL =>DIMINUISH THE FLAT PROTECTION TO FIRE

- THE NEW LOGGIAS TEND TO BECOME MORE OPEN TO THE EXTERIOR BY USING WIDE GLAS ENCLOSURE - AND REPLACING THE EXISTENT PARAPETH

Fire protection for the steel profiles used to consolidate the enlargements created in the interior structural partition concrete diaphragms

-IN FIRE SCENARIOUS FIRE LOADS DIFFER/ IF SO HOW CAN WE PROTECT THE MIXED STRUCTURE

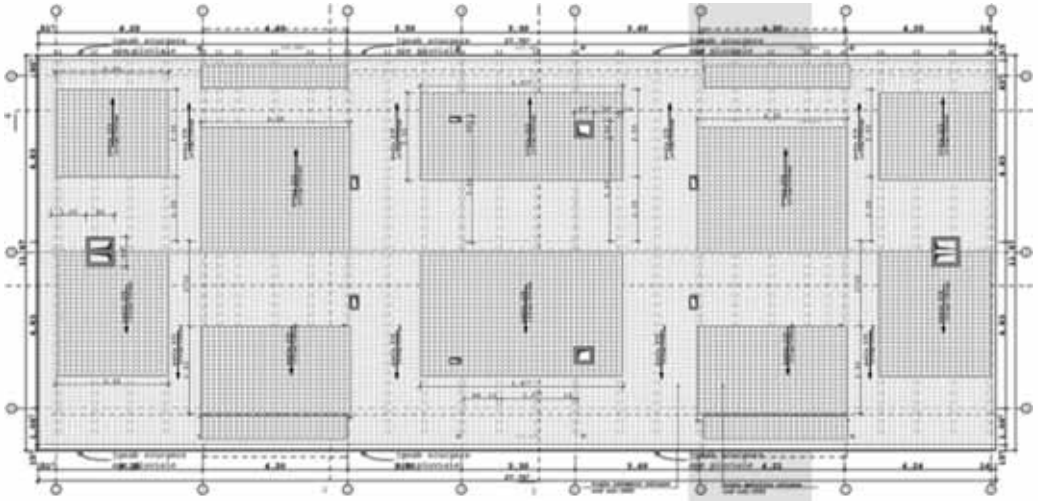
-HOW CAN WE PREVENT FIRE RISK IN THE KITCHEN AREA AFTER EARHQUAKES

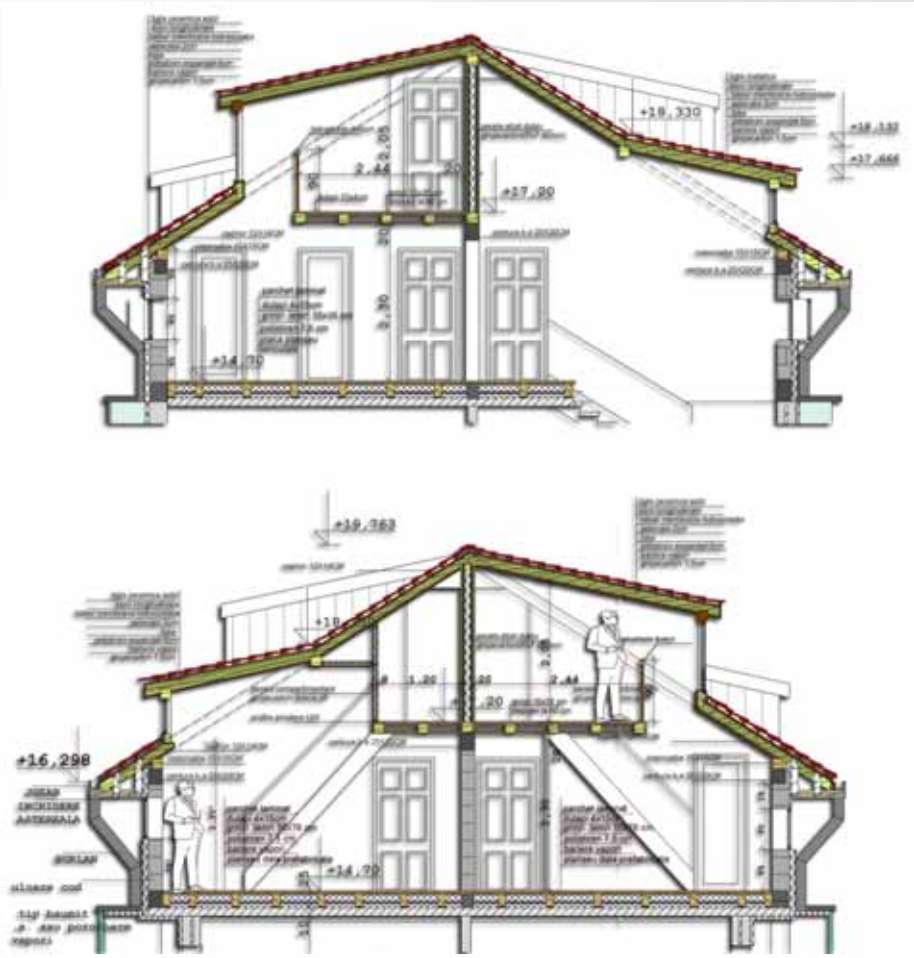
Fire design regulations for the over roofing of these units – fire design, new materials, new systems for fire protection regarding over roofing.

-A FULL SCENARIOUS REGARDING FIRE RISK IS NEEDED FOR THIS KIND OF BUILDINGS?

-THE STAIRCASE REPRESENTS AN OPEN SPACE AMOUNG THE LEVELS

-DUE TO HIGH LEVEL OF VENTILATION THE FIRE CAN SPREAD EASILY





CONCLUSIONS:

- There is a substantial building stock consisting of large prefabricated concrete residential buildings;
- There is a major necessity concerning the rehabilitation of this residential units;
- Concrete residential buildings present the largest retrofitting challenge in Eastern European countries; and one of the best opportunities to substantially improve energy efficiency of residential buildings on the large scale in the EU;
- There are modern technologies with a great potential regarding energy consumption economy.
- The goal is to systematically evaluate retrofit strategies regarding their technological applicability, economic performance, impact on primary energy and CO2-emissions, and interactions with other retrofit needs and to seek for adequate and tailored policy strategies and instruments, depending on building types, actors and institutional or country contexts.

ThankYou.

ACKNOWLEDGMENT

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