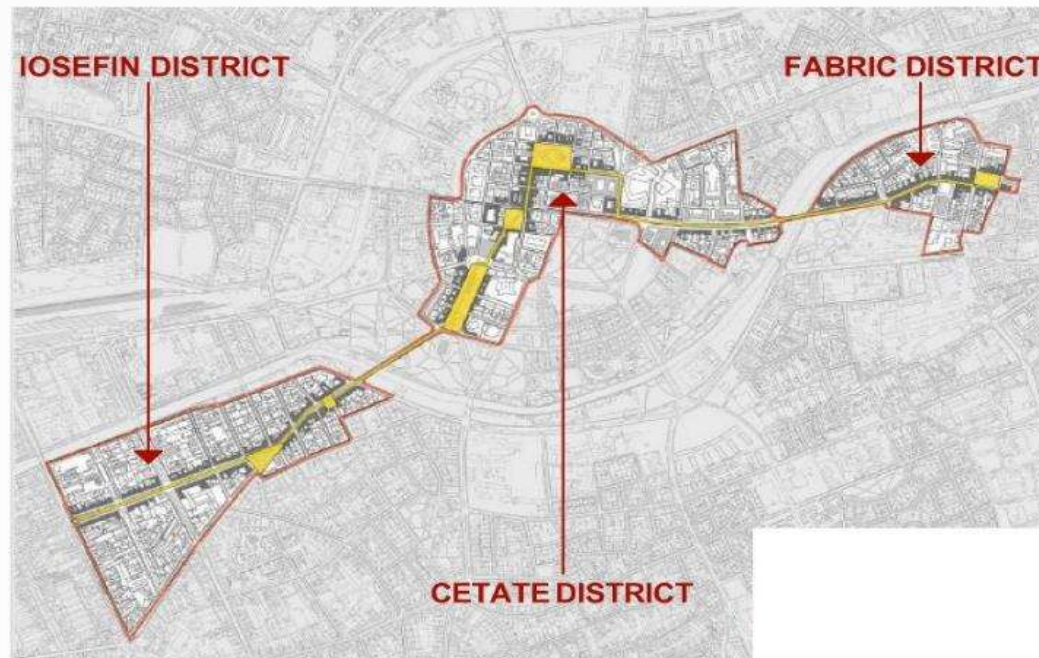


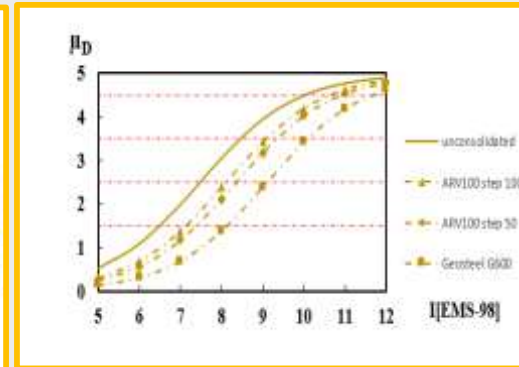
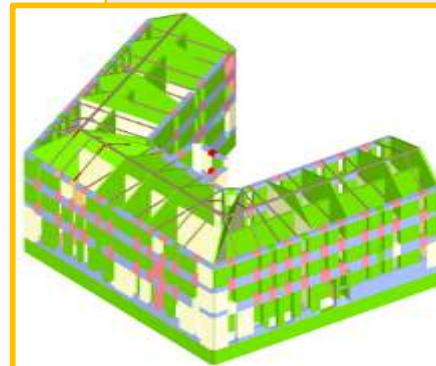
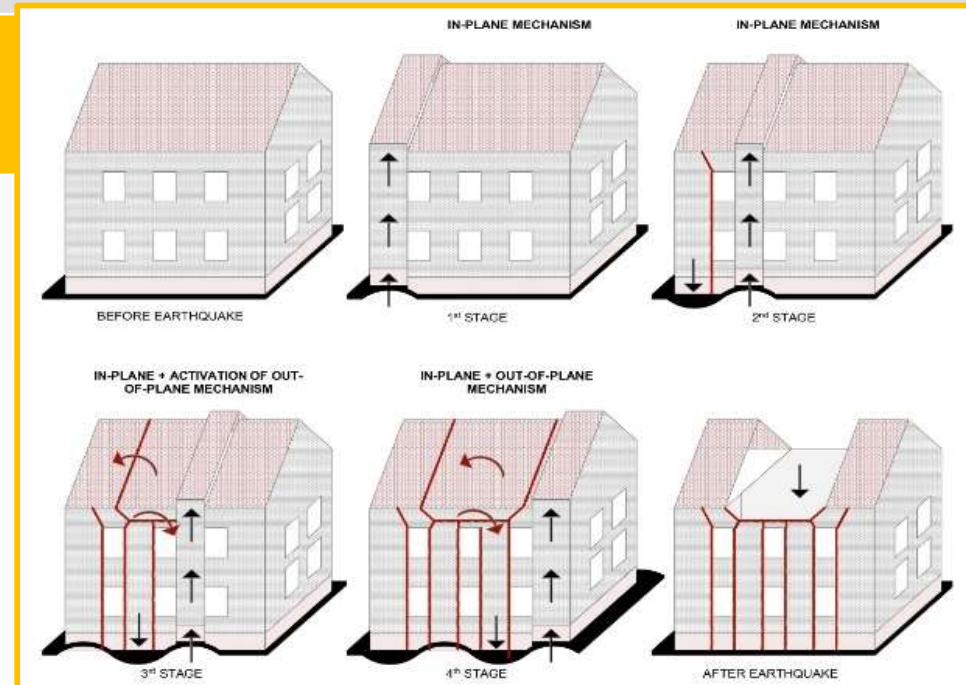
## RAPORT NR. 3 DE CERCETARE INTERMEDIAR, IULIE 2023, AOSR-TEAMS

- **PROIECT: ANALIZA RISCULUI SEISMIC PENTRU CLADIRILE DE PATRIMONIU DIN TIMISOARA CAPITALA CULTURALA EUROPEANA 2023, LA NIVEL MULTIDISCIPLINAR**
- **DIRECTOR DE PROIECT: S.L. HABIL. DR. ARH. IASMINA ONESCU**
- **MEMBRU ECHIPA PROIECT: DRD. ARH. EUGEN ONESCU**





## BAZA PROIECTULUI DEPUȘ

- Definierea unei promenade cultural-istorice în contextul Timișoara Capitala Europeană a Culturii 2023
- Investigatii in-situ pentru peste 100 de cladiri cu valoare de patrimoniu
- Relevee complete și analize neliniare de tip pushover pentru 25 de cladiri istorice



## BAZA PROIECTULUI DEPUȘ

- Calibrarea unei metodologii recunoscute la nivel european pentru cutremurele de suprafață specifice zonei seismice Banat
- Extinderea metodologiei existente astfel încât să considere și valoarea cultural-istorică
- Evaluarea vulnerabilității nu doar structurale, ci și arhitectural-artistice, urbanistice și socio-economice

Bld. No. 1		DISTRICT. IOSEFIN							
%	CRITERIA	No.	ELEMENT	CLASS				WEIGHT	VALUE
				A	B	C	D		
70%	STRUCTURAL	1	Organization of vertical structures	0	5	20	45	1	5
		2	Nature of vertical structures	0	5	25	45	0.25	6.25
		3	Location of the building and type of foundation	0	5	25	45	0.75	18.75
		4	Distribution of plan resisting elements	0	5	25	45	1.5	7.5
		5	Regularity in plan	0	5	25	45	0.5	0
		6	Regularity in elevation	0	5	25	45	1	5
		7	Type of floors	0	5	15	45	1	0
		8	Flooring	0	15	25	45	0.25	33.75
		9	Details	0	0	25	45	0.25	0
		10	Physical conditions	0	5	25	45	1	0
		11	Presence of adjacent buildings with different height	-20	0	15	45	1	45
		12	Position of the buildings in the aggregate	-45	-25	-15	0	1.5	-22.5
		13	Presence and number of staggered floors	0	15	25	45	0.5	12.5
		14	Effect of either structural or typological heterogeneity among adjacent structural unit	-15	-10	0	45	1.2	0
		15	Percentage difference of opening area among adjacent façade	-20	0	25	45	1	0
								Ivstruct s	76.25
								Ivstruct r	111.25
15%	ARCHITECTURAL ARTISTIC	16	Representative architectural style for the area	0	10	15	25	1.5	37.5
		17	Age, importance of the build époque	0	10	15	25	1.2	12
		18	Original woodwork/finery	0	10	15	25	1	10
		19	Original stucco, brick, floors or ceilings	0	10	15	25	1	10
		20	Original statues or bass-reliefs	0	10	15	25	1	0
		21	Original gable/parapet	0	10	15	25	1	10
		22	Original balconies and railings	0	10	15	25	1	10
		23	Original mosaics or stone work	0	10	15	25	1	0
		24	Original paintings or frescoes	0	10	15	25	1	0
		25	Conservation state of artistic assets	-5	10	15	25	1	10
		26	Authenticity/ originality (global, elements)	0	10	15	25	1	10
		27	Official monument (national, regional, local, protected area) status	0	10	15	25	1.5	15
		28	Particular construction techniques/materials	0	10	15	25	0.5	0
		29	Conservation state of original materials	-5	10	15	25	0.5	5
		30	Representative historical events	0	10	15	25	0.5	0
		31	Archaeological site	0	10	15	25	1.5	0
		32	Representative original wooden framework	0	10	15	25	1	0
		33	Past restoration work	-5	10	15	25	1	10
								Ivartecst.	139.5
10%	URBANISTIC	34	Importance in contouring the street profile	-5	10	15	25	1.5	15
		35	Importance in contouring the urban silhouette	-5	10	15	25	1.5	15
		36	Annexes, relation with the urban pattern	0	10	15	25	1	0
		37	Location (central area, touristic area)	0	10	15	25	1.5	37.5
38	Representative/particular shape of the roof	0	10	15	25	1	0		
								Ivurban.	67.5
5%	SOCIAL ECONOMIC	39	Public/social functions	0	10	15	25	1.5	0
		40	Importance for the local community memory	-5	10	15	25	1	-5
		41	Economic value	0	10	15	25	1.5	15
42	Cultural functions	0	10	15	25	1.5	0		
								Ivsoc.econ.	10
								Ivtotal	106.05
Foto									

## PROIECTUL DEBUS - METODOLOGIE

- Proiectul continua cercetarile originale realizate in cadrul tezei de doctorat intitulata "Seismic vulnerability assessment of historical urban centers", fiind în concordanță cu preocupările ICOMOS, care încurajează o evaluare multidisciplinară a clădirilor istorice, urmărește reducerea riscului seismic și, prin aceasta, protejează patrimoniul cultural.
- Baza acestei cercetări o reprezintă metodologiile existente de evaluare a vulnerabilității, validate la nivel international, care au fost propuse de universități recunoscute precum Universitatea Federico II din Napoli, Universitatea din Padova și Universitatea din Genova pentru zona Italiei.
- Metodologia originala utilizeaza calibrarea realizata prin analize numerice si comparatii cu avarii din trecut, inasa este o metodologie empirica, usor de aplicat la scara urbana, rapida si simplificata.

## PROIECTUL DEPUȘ - OBIECTIVE

- **Calibrarea metodologiei propuse prin extinderea numărului de clădiri analizate**
- **Calibrarea metodologiei propuse prin discuții și analize cu alți cercetători**
- **Extinderea hărților de risc seismic pentru zonele istorice ale orașului Timișoara**
- **Realizarea unor hărți digitale și interactive pentru orașul Timișoara, care să permită completarea diverselor informații în timp real**
- **Cresterea nivelului de informare la nivelul locuitorilor din zonele investigate**
- **Organizarea de workshop-uri în cartierele istorice din Timișoara, atât pentru studenții Facultății de Arhitectură, cât și pentru locuitorii clădirilor investigate**
- **Diseminarea rezultatelor în cadrul conferințelor și publicațiilor științifice**

## PROIECTUL DEPUȘ - RELEVANȚA

- În prezent, multe echipe multidisciplinare din întreaga lume investighează vulnerabilitatea la seism a clădirilor de patrimoniu. Implicarea echipei de cercetare din Timișoara va crește vizibilitatea României pe plan internațional în acest domeniu.
- Subiectul proiectului este dezbătut la scară largă în reviste internaționale importante cu factor de impact și în câteva conferințe de renume internațional, precum SAHC, PROHITECH, IB2MAC, ICSA, ICEFA și altele care ilustrează importanța și actualitatea temei.
- Proiectul rezolvă dificultatea realizării unor expertize tehnice costisitoare și care durează asupra unui număr mare de clădiri, oferind informații preliminare concludente, cu resurse minime de timp și bani



## PROIECTUL DEPUȘ - PLANIFICATOR

ACTIVITATE	2022											
	IAN	FEB	MAR	APR	MAI	IUN	IUL	AUG	SEP	OCT	NOV	DEC
Extindere numărului de clădiri analizate și calibrarea metodologiei pe baza rezultatelor												
Discuții cu cercetători din domeniu și calibrare metodologiei pe baza concluziilor												
Transmiterea unui articol științific în revista științifică indexată WOS												
	2023											
	IAN	FEB	MAR	APR	MAI	IUN	IUL	AUG	SEP	OCT	NOV	DEC
Extinderea hărților de risc seismic pentru cartierele istorice din Timișoara												
Organizarea de workshop-uri cu studenți arhitecți												
Organizarea de workshop-uri cu locuitori din zonele investigate												
Diseminarea informațiilor în cadrul unei conferințe indexate WOS												
Discuții cu cercetători din domeniu și calibrare metodologiei pe baza concluziilor												
Transmiterea unui articol științific în revista științifică indexată WOS												
Finalizarea calibrării metodologiei și a hărților interactive de risc seismic												
Organizarea unei întâlniri cu autoritățile locale												

## PROIECTUL DEBUS – REZULTATE OBTINUTE

- Am purtat discutii cu prof. Eythor Thorhallsson, de la Reykjavik University si am efectuat o deplasare in Reykjavik in perioada 28 august-2 septembrie 2022.
- Am purtat discutii cu prof. Antonio Formisano din Napoli si prof. Michele D'Amato in cadrul unei deplasari efectuate la Universita degli Studi della Basilicata, din Matera, Italia, in perioada 8-12 noiembrie 2022.
- Am purtat discutii cu prof. arh. Caterina Carocci in cadrul unei deplasari efectuate la Universita degli Studi di Catania, din Siracusa, Italia, in perioada 30 noiembrie – 2 decembrie 2022.
- Am sustinut un workshop de vulnerabilitate in calitate de profesor invitat in cadrul Universitatii Politehnice din Bari, in perioada 30 mai – 2 iunie 2023, in cadrul caruia am purtat discutii de calibrare cu prof. ing. Giuseppina Uva si conf. ing. Sergio Ruggieri.



## PROIECTUL DEPUȘ – REZULTATE OBTINUTE

- Pana in prezent, am organizat o practica de vara cu studentii Facultatii de Arhitectura, practica la care au participat 28 de studenti, care au determinat vulnerabilitatea la seism, respectiv cea culturala pentru inca 250 de cladiri istorice din Timisoara – obiectiv raportat in luna decembrie 2022.
- In urma castigarii unei competitii de scoli de vara in parteneriat cu D.A.A.D., am organizat o a doua practica de vara in iulie 2023, practica la care participa si studenti din Germania (finantati de catre guvernul German), in cadrul careia se va determina vulnerabilitatea multicriteriala a cladirilor dintr-o piateta istorica din Timisoara; mai mult, aceasta practica va presupune si realizarea unui workshop cu locuitorii zonei, respectiv a unui workshop cu autoritatile locale.
- Am continuat analizarea datelor obtinute, am calibrat metodologia si am inceput transpunerea rezultatelor sub forma de articole stiintifice.

## PROIECTUL DEPUS – REZULTATE OBTINUTE

- Am prezentat rezultatele intermediare ale cercetării în cadrul următoarelor conferințe științifice (cu un număr de 7 lucrări științifice):
- 3ECCES 2022, desfășurată la București în luna septembrie 2022
- ANIDIS 2022, desfășurată la Torino în luna septembrie 2022, conferința cu volum de Proceedings indexat Scopus
- 7th World Multidisciplinary Civil Engineering – Architecture – Urban Planning Symposium, desfășurată la Praga în luna septembrie 2022, conferința cu volum de Proceedings indexat ISI
- Conferința GNGTS desfășurată la Bologna în luna februarie 2023
- 9th International Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, desfășurată la Atena în luna iunie 2023, conferința cu volum de Proceedings indexat Scopus

## CASE STUDY OF THE SEISMIC VULNERABILITY OF A HISTORICAL BUILDING IN TIMISOARA, ROMANIA

Eugen ONESCU<sup>1</sup>, Iasmina ONESCU<sup>2\*</sup>, Marius MOSOARCA<sup>1</sup>, Alexandru ION<sup>3</sup>

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<sup>2</sup>Politehnica University of Timisoara, P-ta Victoriei 2, 300006, Timisoara, Romania; Academy of Romanian Scientists, B-va 2, 050044, Bucharest, Romania

<sup>3</sup>The National Institute of Research and Development in Civil Engineering, 710506, Timisoara, Romania

COMPEN 2023

## APPLICATION OF HAZARD RISK METHODOLOGY ON HISTORICAL BUILT ENVIRONMENT IN TIMISOARA

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### ABSTRACT

The multi-hazard risk assessment of the built environment, especially in historical urban areas, represents a common topic nowadays, with many challenges in the management process.

Timisoara, which will be the European Capital of Culture in 2023, has several historical areas which present various vulnerabilities to hazards, especially to earthquakes. Heritage buildings in Art Nouveau, Baroque, Secession architectural style present a poor state of conservation, without recent consolidation work and also without a specific knowledge of their expected damage state in case of an earthquake. Considering the fact that Timisoara is located in Banat seismic area, which is characterized by shallow earthquakes of crustal type, the opportunity of investigating the vulnerability of the most important districts of the city is highlighted.

The paper presents a multi-disciplinary empirical vulnerability assessment made on a historical area of Timisoara city, which investigated the structural, architectural-artistic, urbanistic and socio-economic vulnerability of the case-study area, in a simplified and efficient way. The assessment methodology represents a complex, holistic methodology that was proposed by the same authors recently, which aims to consider the cultural value of the heritage buildings in the process of multi-hazard risk management of the built environment.

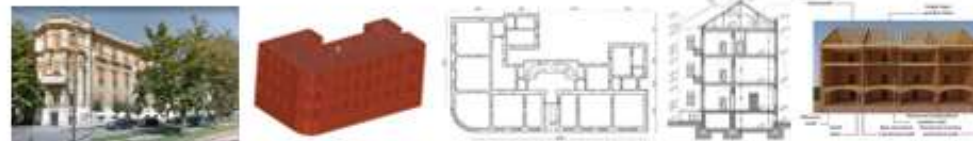
### Introduction

Timisoara is a city located in the western part of Romania, in an area characterized by shallow earthquakes of crustal type, with a design seismic acceleration  $a_g=0.20g$ . The city has a lot of historical buildings in Secession, Art Nouveau and Baroque architectural style, located in Cetate, Josafin and Fabric districts. The typical buildings are made in brick masonry and lime, with massive perimeter walls and masonry vaults or wooden floors. All of them were built before the existence of any design codes in Romania and many of them are in a poor conservation state, highlighting the necessity of assessing their seismic vulnerability. This paper presents the case study of one of these historical beautiful buildings in Timisoara, study which aims to assess the seismic vulnerability of the building. The vulnerability was determined both with empirical and analytical methodologies.



### Material and Methods

The investigated building is located in Fabric district (Figure 8), on street Prof. Dr. Ion Linta no. 2. Was built in 1903 in Eclectic architectural style and was designed by the arch. Gabor Fodor, with a rectangular plan shape, 3 levels, receiving the name of 'Karl Kunz palace' because was built for the entrepreneur Karl Kunz. Karl Kunz Palace was built in masonry of burnt clay brick and lime, without any significant changes or alterations of the original construction materials until nowadays. The perimeter brick walls are the thickest ones, with thicknesses between 80 centimetres at the basement to 30-40 centimetres at the top floor. Another massive brick wall is present as a median interior wall, parallel with the main facade. The transversal walls are much thinner, playing a role mostly for the rigidity of the building, having thickness of 10 to 15 centimetres. The main facades are following the street pattern, while the corner of the building is marked by a chamfered small facade and very present balconies and fronton. Regarding the horizontal structural elements, above the basement there are masonry vaults, while at the rest of the floors there are wooden floors.

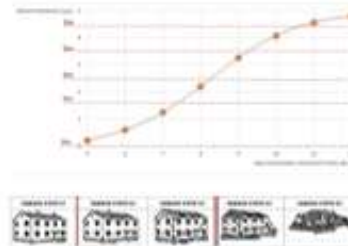


### Results

For Karl Kunz Palace, there was performed a hybrid vulnerability assessment, which included an empirical visual inspection, as well as a numerical nonlinear analysis. The empirical methodology that was used is based on the methodology proposed in the past by Benedetti and Petrini for 50 parameters, developed by Mazzolani and Formisano for 15 parameters and was recently extended by Onescu and Mosoarca so it would consider also architectural-artistic, urbanistic and socio-economic parameters, leading to a final investigation form with 42 parameters.

The mechanical procedure is based on the determination of the capacity curve, compared with the demand of a local earthquake, using Tremuri software. The nonlinear analysis performed on Karl Kunz Palace indicates possible bending failure to the lintels especially at the top part of the building, as well as shear possible failure at the spandrels especially at the bottom part of the building, at the ground floor facade walls.

The results are presented in Figure 16, highlighting also a most probable damage state D3 for the considered macroseismic intensity IX EMS-98, with a slighter lower vulnerability that the one indicated by the empirical methodology.

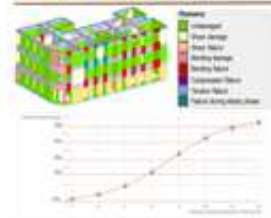


### Discussions & Conclusions

The results of the study have shown two interesting conclusions.

The first one is that heritage masonry buildings in Timisoara could suffer moderate damages in case of an earthquake typical for Banat seismic area, without presenting the risk of losing the bearing capacity. However, when the cultural value of the building is considered, the vulnerability can suffer a slight increase, and when this cultural value is taken into account, the moderate damage state highlights the possibility of losing valuable architectural-artistic assets.

The second conclusion that comes from this study is that the empirical seismic vulnerability assessment influenced by the cultural value that was developed by the authors has similar results with the mechanical analysis, illustrating a good correlation and demonstrating that the empirical procedure is appropriate for a quick and simplified vulnerability assessment at a territorial scale.



### Acknowledgements

This paper was written under the National Research Grant AOSR-TEAMS 2022-2023, research director Iasmina Onescu, offered by The Academy of Romanian Scientists.

## PROIECTUL DEPUȘ – REZULTATE OBTINUTE

- Am scris și transmis spre evaluare alte 5 lucrări științifice pentru trei congrese internaționale de renume, care au fost acceptate sau sunt în curs de publicare:
- 8th World Multidisciplinary Civil Engineering – Architecture – Urban Planning Symposium 2023 (Praga), conferința cu volum de Proceedings indexat ISI, 2 lucrări științifice
- International Conference on Structural Analysis of Historical Constructions SAHC 2023 (Kyoto), conferința cu volum de Proceedings indexat Scopus, 2 lucrări științifice
- World Conference on Earthquake Engineering 2024 (Milano), conferința în cadrul căreia sunt invitată în calitate de Invited Speaker în cadrul sesiunii Towards a new vision of civil engineering: Digital innovation in structural health management

## PROIECTUL DEPUS – REZULTATE OBTINUTE

- Am publicat 3 articole in jurnale stiintifice cu impact factor, din cartila Q1, indexate WOS:
- Journal of Building Engineering, IF 7.14, lucrarea intitulata *Seismic risk assessment and crisis management for historical buildings in Timisoara*
- Engineering Failure Analysis, IF 3.63, lucrarile intitulate *Seismic risk assessment of Romanian masonry churches in the Banat area through a multilevel analysis framework*, respectiv *Failure mechanism of historic churches in Gorj county for shallow seismic action*

Journal of Building Engineering 72 (2023) 106665

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**BUILDING ENGINEERING**

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### Seismic risk assessment and crisis management for historical buildings in Timisoara

Iasmina Onescu<sup>a, b, c, \*</sup>, Eugen Onescu<sup>a</sup>, Marius Mosoarca<sup>a, b</sup>

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**ARTICLE INFO**

**Keywords:**  
Masonry  
Historical building  
Numerical analysis  
Seismic vulnerability  
Assessment

**ABSTRACT**

Historical masonry buildings represent a research topic of interest, as many European cities have a large number of heritage buildings which must be preserved. Timisoara city, located in the western part of Romania, has a history of various dominations, leading to a historical cluster of the city, where masonry buildings in Secession, Art Nouveau and Baroque architectural style can be found. The city is also located in Banat seismic region, the second most important seismic area of Romania, characterized by shallow earthquakes of crustal type. Many of the existing buildings in historical districts are in a poor conservation state, so the seismic vulnerability assessment is necessary, especially considering the fact that Timisoara will be the European Capital of Culture in 2023.

Seismic vulnerability assessment represents a useful tool in the process of the multidisciplinary vulnerability investigation of historical buildings. The assessment procedure can be obtained through empirical, mechanical or hybrid methods, each one of them being appropriate for a specific scale of the investigated area.

This paper presents the mechanical seismic vulnerability assessment of 25 case study historical masonry buildings located in Timisoara city, Romania. The assessment is made based on complete survey and numerical nonlinear analysis made with Tremuri software. The results are presented for each type of the investigated buildings, also illustrating the vulnerability curves for a specific seismic scenario, as well as the expected damage state. Moreover, there are obtained also the fragility curves for each building type, while a comparison of results is also discussed.

The study has the aim to determine the general seismic vulnerability of each building type in the historical districts of Timisoara, to highlight the bearing capacity of the investigated buildings and to compare the vulnerability and fragility curves results.

#### 1. Introduction

Heritage represents the base of each community's identity, and it must be preserved for further generations. Heritage buildings are exposed to several risk factors, such as earthquakes. The seismic risk represents a permanent threat for cities located in seismic areas,



## PROIECTUL DEPUȘ – REZULTATE PLANIFICATE ÎN PERIOADA URMĂTOARE

- Extinderea hartilor de risc seismic si cultural pe baza rezultatelor obtinute in luna iulie 2023 – estimare finalizare luna septembrie 2023
- Fructificarea workshopurilor realizate in iunie la Bari si in iulie la Timisoara, cu cercetatori din domeniu si publicarea rezultatelor discutiilor in cel putin alte doua articole in jurnale indexate WOS, cuartila Q1 – estimare finalizare luna septembrie 2023
- Finalizarea hartilor interactive si realizarea unei aplicatii digitale pentru facilitarea accesului la informatia privind vulnerabilitatea cladirilor istorice din cartierul Iosefin, Timisoara – estimare finalizare luna decembrie 2023
- Organizarea unei discutii cu autoritatile locale pentru facilitarea colaborarii – estimare finalizare luna decembrie 2023

- Va multumesc pentru atentie!

- [iasmina.onescu@upt.ro](mailto:iasmina.onescu@upt.ro)