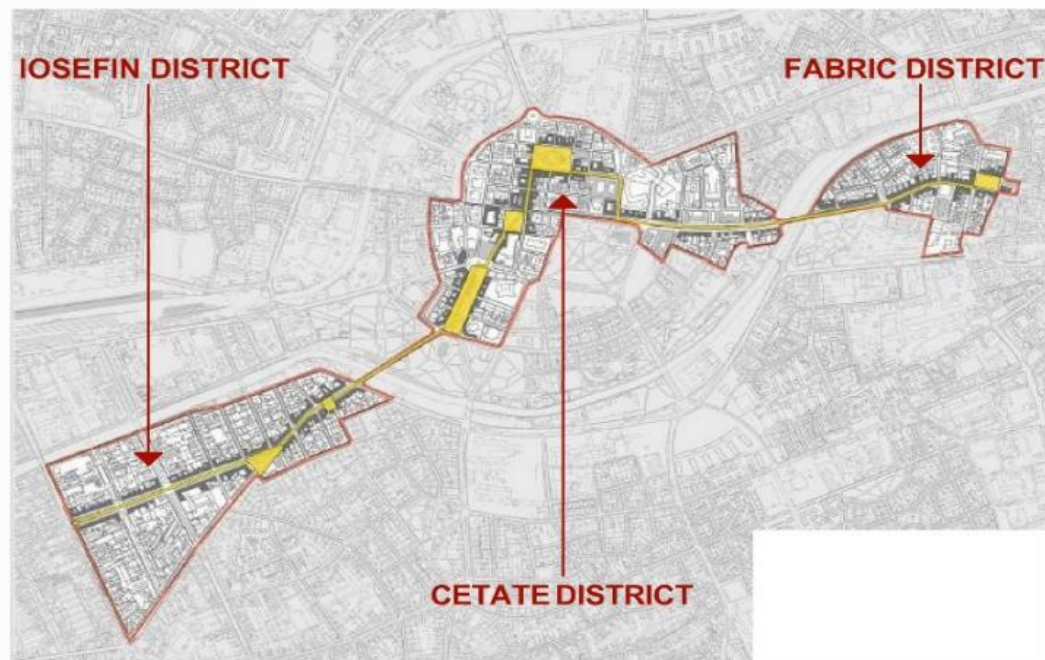


RAPORT NR. 2 DE CERCETARE INTERMEDIAR, DEC 2022, AOSR-TEAMS

**PROIECT: ANALIZA RISCULUI SEISMIC PENTRU CLADIRILE DE PATRIMONIU DIN
TIMISOARA CAPITALA CULTURALA EUROPEANA 2023, LA NIVEL MULTIDISCIPLINAR**

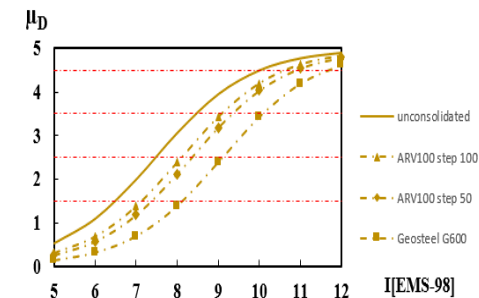
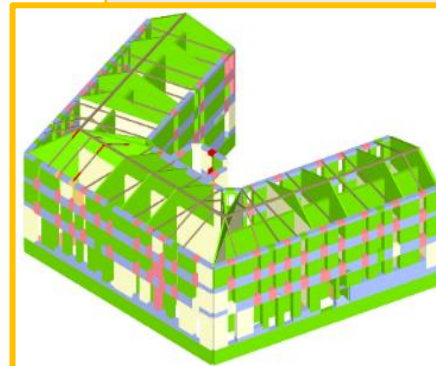
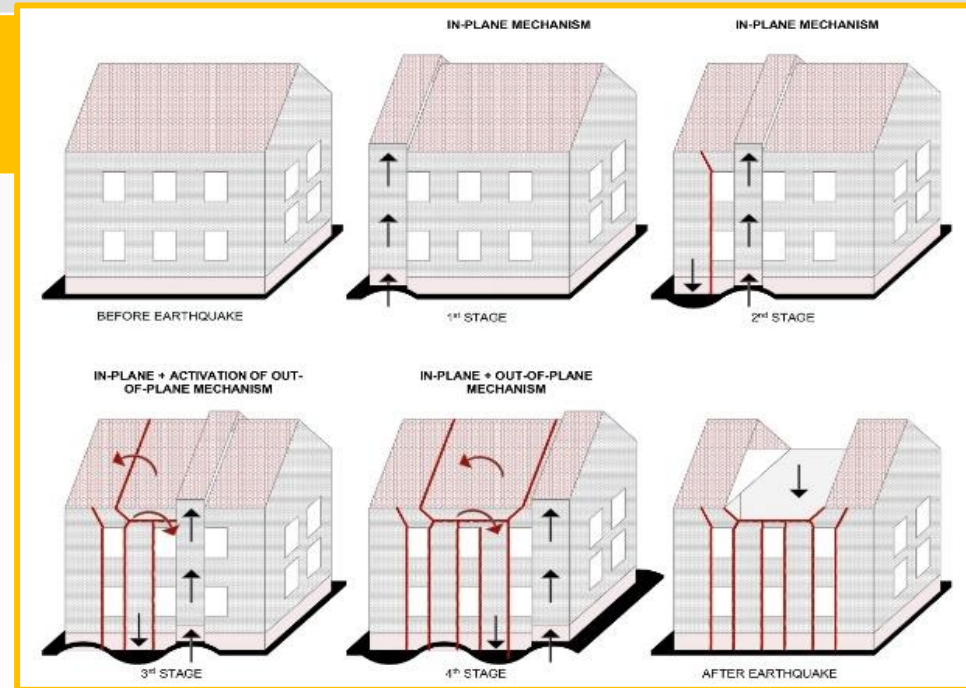
DIRECTOR DE PROIECT: S.L. DR. ARH. IASMINA ONESCU

MEMBRU ECHIPA PROIECT: DRD. ARH. EUGEN ONESCU





BAZA PROIECTULUI DEPUȘ

- Definirea unei promenade cultural-istorice în contextul Timisoara Capitala Europeana a Culturii 2023
- Investigatii in-situ pentru peste 100 de cladiri cu valoare de patrimoniu
- Relevee complete si 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-artistică, urbanistică și socio-economică

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	0.75	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.	76.25
									Ivstruct.	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/joinery	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/iron	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			
									Ivart.	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 DEPUȘ - 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, insa 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
- Creșterea 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 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, respective cea culturala pentru inca 120 de cladiri istorice din Timisoara – obiectiv raportat in luna iulie 2022
- Am inceput analizarea datelor obtinute, am calibrat metodologia si am inceput transpunerea rezultatelor sub forma de articole stiintifice – obiectiv raportat in luna iulie 2022
- 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



SEISMIC RISK ANALYSIS FOR HISTORIC AREAS. CASE STUDY: FABRIC DISTRICT, TIMISOARA EUROPEAN CAPITAL OF CULTURE 2023

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PROIECTUL DEPUȘ – REZULTATE OBTINUTE

- Am purtat discutii cu prof. arh. Caterina Carocci in cadrul unei deplasari efectuate la Universita degli Studi di Catania, din Siracuza, Italia, in perioada 29 noiembrie-03 decembrie 2022
- Am prezentat rezultatele intermediare ale cercetarii in cadrul conferintei stiintifice 3ECCES 2022, desfasurata la Bucuresti in luna septembrie 2022, cu lucrarea intitulata *SEISMIC RISK ANALYSIS FOR HISTORIC AREAS. CASE STUDY: FABRIC DISTRICT, TIMISOARA EUROPEAN CAPITAL OF CULTURE 2023*

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 3 historical districts, Cetate, Iosefin and Fabric. Fabric district appeared as a settlement for craftsmen, with a population bigger than Cetate district, which is the district inside the former fortification walls. Fabric district has a large number of heritage buildings built in Secession, Art Nouveau and in some cases Baroque architectural style, connected with the city centre through a historical bridge. There were selected for investigation the buildings along the main street, leading to a total number of 37 investigated buildings.



Empiric seismic vulnerability assessment

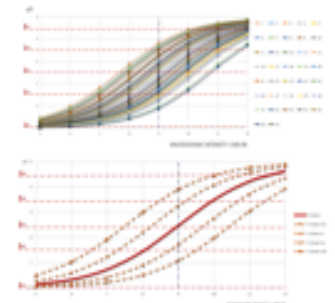
The buildings are made in brick masonry of burnt clay brick and lime, with perimetral walls of 40-80 cm thicknesses and also a thick median longitudinal wall. The transversal walls are 10-15 cm thick and in most of the cases there isn't any connection with the lapade walls. Most of the buildings present basement, with brick arches and vaults of 15-20 cm thickness, while the rest of the floors are usually made in wood with a single or double layer of wooden beams. The majority of buildings present a massive slope roof with complex and rigid wooden framework that can reach up to 4 meters height.

The empiric seismic vulnerability assessment is based on a quick and simplified methodology that was proposed at first by prof. Benedetti and prof. Petriani and developed later by prof. Mazzolani and prof. Formisano. The final procedure consists in fulfilling a vulnerability form of 15 parameters, each with a specific weight, while the vulnerability index is the sum of the specific weighted parameters.

The average vulnerability curve and vulnerability range for the investigated building was determined following the possible variability of damage ($V_{MEC} \text{ mean} - 2\sigma$; $V_{MEC} \text{ mean} - \sigma$; $V_{MEC} \text{ mean} + \sigma$; $V_{MEC} \text{ mean} + 2\sigma$), where σ represents the standard deviation of the vulnerability indexes. Considering the most probable IX EMS-98 macroseismic intensity for Timisoara, the results indicate a moderate medium vulnerability of D3 damage state, with a range of reaching D1-D4 damage states. The correlation of the damages states D1-D5 with the expected real damage for masonry buildings in areas with shallow earthquakes was proposed by the authors.



Parameter	Value	Weight	Weighted Value
Number of floors	3	10	30
Roof type	Slope	15	45
Wall thickness	40-80 cm	10	40
Material	Brick masonry	10	10
Basement	Present	10	10
Arch/vault	Present	10	10
Wooden beams	Present	10	10
Complex framework	Present	10	10
Height	Up to 4m	10	10
Total			165



Results & Conclusions

The vulnerability curves indicate the fact that the mean vulnerability of Fabric historic area for the indicated seismic scenario can be considered a medium one, with high possibility of having moderate to severe damages to non-structural elements and small to considerable damages to structural ones. Despite the medium vulnerability indicated by the methodology, there must be considered another important factor, such as the historical and architectural-artistic value of the investigated buildings. Even non-structural damage can lead to severe decay to artistic assets, so the expected damage level for buildings with heritage value should be limited through prevention and intervention measures. Such measures should be part of a multidisciplinary strategy with the main purpose of preparing the city, the community and the authorities for preventing losses, reducing damages and seismic risk.

Acknowledgements

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

PROIECTUL DEPUȘ – REZULTATE OBTINUTE

- Am scris și transmis spre evaluare trei lucrări științifice pentru trei congrese internaționale de renume, care au fost acceptate:
- 7th World Multidisciplinary Civil Engineering – Architecture – Urban Planning Symposium 2022, conferința cu volum de Proceedings indexat ISI, lucrarea intitulată *Case study of the seismic vulnerability of a historical building in Timisoara, Romania*
- International Conference on Structural Analysis of Historical Constructions SAHC 2023, conferința cu volum de Proceedings indexat Scopus, lucrarea intitulată *Seismic and cultural vulnerability assessment of a small historical urban area in Timisoara city, Romania*
- 9th International Conference on Computational Methods in Structural Dynamics and Earthquake Engineering 2023, conferința cu volum de Proceedings indexat Scopus, lucrarea intitulată *APPLICATION OF HAZARD RISK METHODOLOGY ON HISTORICAL BUILT ENVIRONMENT IN TIMISOARA*

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

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³The National Institute of Research and Development in Geology, Geology Institute of Romania, Bucharest, Romania

COMPdyn 2023

APPLICATION OF HAZARD RISK METHODOLOGY ON HISTORICAL BUILT ENVIRONMENT IN TIMISOARA

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Introduction

Timisoara is a city located in the western part of Romania, in an area characterised 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, Iosefin and Fabric districts. The typical buildings are made in brick masonry and lime, with massive perimetral 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. Ionisie Lintea 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 Kurz palace' because was built for the entrepreneur Karl Kurz. Karl Kurz 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 perimetral 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 main 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.

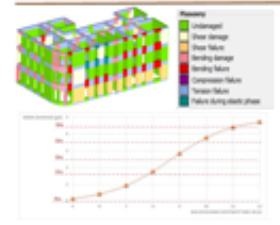
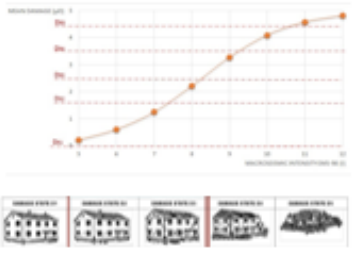


Results

For Karl Kurz 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 30 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 Kurz 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.

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.

PROIECTUL DEPUS – REZULTATE OBTINUTE

- Am scris si transmis spre evaluare o lucrare stiintifica pentru un jurnal internationale de renume, care este in curs de evaluare:
- Journal of Building Engineering, jurnal indexat ISI, IF 7.14, quartila Q1, lucrarea intitulata *Seismic risk assessment and crisis management for historical buildings in Timisoara*

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Seismic risk assessment and crisis management for historical buildings in Timisoara

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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.

Journal of Building Engineering

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Submissions Being Processed for Author

Page: 1 of 1 (1 total submissions) Results per page: 10

Action	Manuscript Number	Title	Initial Date Submitted	Status Date	Current Status
View Submission View Reference Checking Results Send E-mail	JBE-D-22-06883	Seismic risk assessment and crisis management for historical buildings in Timisoara	Sep 28, 2022	Sep 29, 2022	Under Review

PROIECTUL DEPUȘ – REZULTATE PLANIFICATE ÎN PERIOADA URMĂTOARE

- Extinderea hartilor de risc seismic și cultural pe baza rezultatelor obtinute în luna iulie, asupra celor 120 de cladiri nou investigate – estimare finalizare luna mai 2023
- Fructificarea intalnirilor stabilite în august, respectiv noiembrie, cu cercetatori din domeniu și publicarea rezultatelor discutiilor – estimare finalizare luna iulie 2023
- Finalizarea și transmiterea spre evaluare a unui articol stiintific cu rezultatele deja obtinute într-un al doilea jurnal indexat Web of Knowledge, quartila Q1– estimare finalizare luna septembrie 2023
- Organizarea unui workshop cu student arhitecti din Romania și din Europa, respective cu locuitorii din zonele investigate – estimare finalizare luna septembrie 2023