Virtual Earthquake Reconnaissance Team (VERT): Phase 1 Response to M6.4 Albania Earthquake November 26, 2019

By:

Mohammad Alam, Yolanda Alberto, Chrysl Aranha, Guillermo Diaz-Fanas, Wilfrid Djima, Mikael Gartner, Wael Hassan, Brisid Isufi, Maha Kenawy, Edwin Lim, Sissy Nikolaou,Tona Rodriguez-Nikl, Mehmet Unal, Hartanto Wibowo, David Yoo, Erica Fischer, and Manny Hakhamaneshi

for questions contact VERT co-chairs:
Erica Fischer (erica.fischer@oregonstate.edu)
Manny Hakhamaneshi (manny.hakhamaneshi@dot.ca.gov)

Please Note: This report is based on publicly available data within 48 hours of the events. The assessment provided in the report is performed by the judgment of the authors with limited access to ground-truthing.

Topic: Earthquake Characteristics

VERT Phase 1 Response for:
M6.4 Albania Earthquake

Earthquake Characteristics

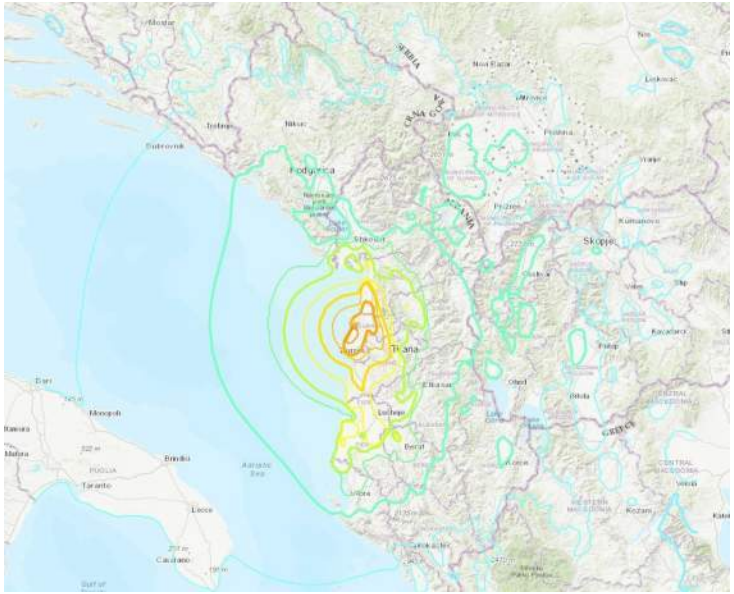
Date: 2019-11-26 02:54:12 (UTC)

Magnitude: Mw 6.4 *(USGS)*

Location:

- Epicenter located 16km WSW of Mamurras
- 41.511°N and 19.515°E

Depth: 20 km *(USGS)*



M6.4 Albania Earthquake

https://earthquake.usgs.gov/earthquakes/eventpage/us70006d0m/map

Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

Fault Mechanism:

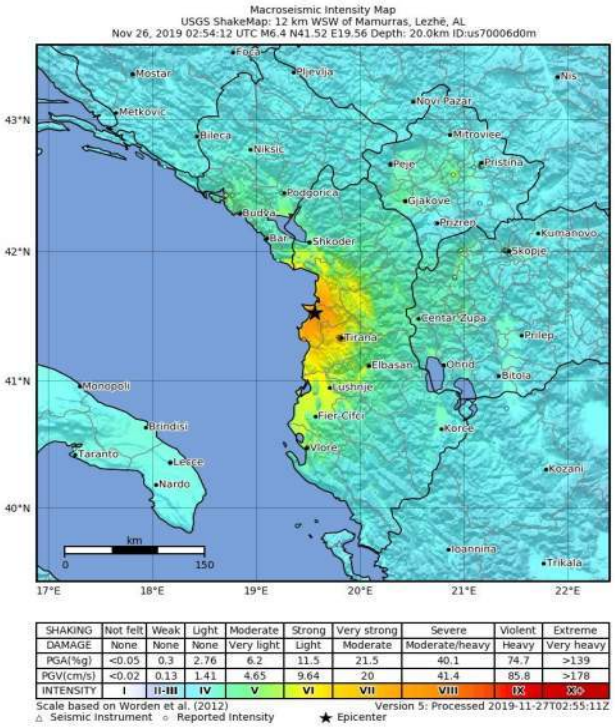
- The earthquake occurred as the result of thrust faulting near the convergent boundary of the Africa and Eurasia plates.

  Note that at the location of the event, the Africa plate converges with the Eurasia plate at a rate of 73 mm/year.

- The focal mechanism solutions indicate reverse slip on a shallow or steeply dipping fault.

Max Intensity:

- Severe shaking
- Moderate/Heavy damage



Summary of Location, Fatalities, Fault Mechanism, and other Statistical Data

Impact on human safety:

- 51 fatalities reported
- 2,000 injuries reported

Impact on society:

- >USD100M worth of estimated damage (https://earthquake.usgs.gov/earthquakes/eventpage/us70006d0m/pager)
- 4,000 people are homeless
- 2,500 people from damaged homes have been sheltered

Relief:

The Albanian government has established a monetary compensation scheme that would give the families of deceased people scholarships to children, pensions for the elderly and 1 million lek for a family.

(https://www.timesunion.com/news/world/article/Albania-s-search-for-quake-victims-ends-death-14872144.php#item-85307-tbla-5)

Rescue workers carry an injured man found in the debris of a collapsed building in Thumane, Albania https://metro.co.uk/2019/11/30/devastating-earthquake-albania-leaves-50-dead-4000-homeless-11246475/

Topic: Building Codes

VERT Phase 1 Response for:
M6.4 Albania Earthquake

Summary of Building Codes

- 1978 Building Code KTP-78 (Technical Design Conditions) (still in effect)
- Public construction sector: design and construction regulated and controlled by central government until 1990
- Following collapse of Soviet Union, private sector and free market since 1990 onward: Construction Boom
- 1990-2001: First decade of construction boom:
  NO STATE CONTROL OR CODE REGULATION

KTP-78

Ref: Rikard Luka: "Present Status of Eurocodes in Albania", 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

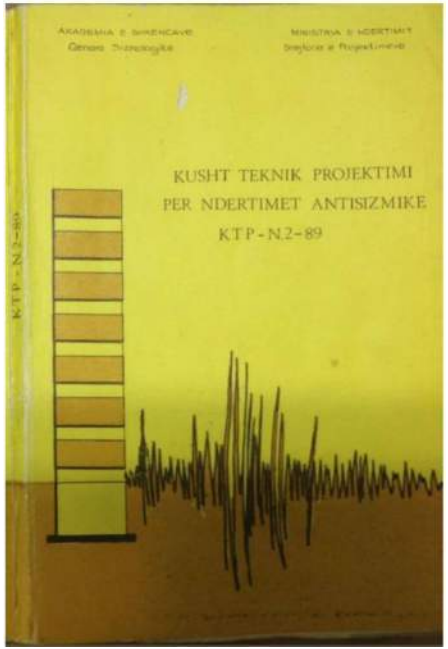
Summary of Building Codes

1990-2001: Construction Boom: NO CODE REGULATION

Ref: Rikard Luka: “Present Status of Eurocodes in Albania”, 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Summary of Building Codes

- 1989 Last known Seismic Code update KTP-N2-89
- No enforcement between 1990-2000
- Level of enforcement 2001-2012 unknown
- Currently still in effect until Eurocode's adopted Albanian Standards (next slides) are officially "Albanian Technical Codes"



KTP-N2-89

Ref: Rikard Luka: "Present Status of Eurocodes in Albania", 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Summary of Building Codes

- In 2012: First Stage of Eurocode Adoption
- 2012 Albanian Standard (not code):

  SSH EN 1990 +A1

  SSE EN 1998 Parts 1, 2, 5

- Currently: voluntary adoption since KTP-78 must still be followed

First Stage of Eurocode Adoption

Ref: Rikard Luka: "Present Status of Eurocodes in Albania", 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Summary of Building Codes

- In 2013: Second Stage of Eurocode Adoption
- 2013 Albanian Standard (not code):

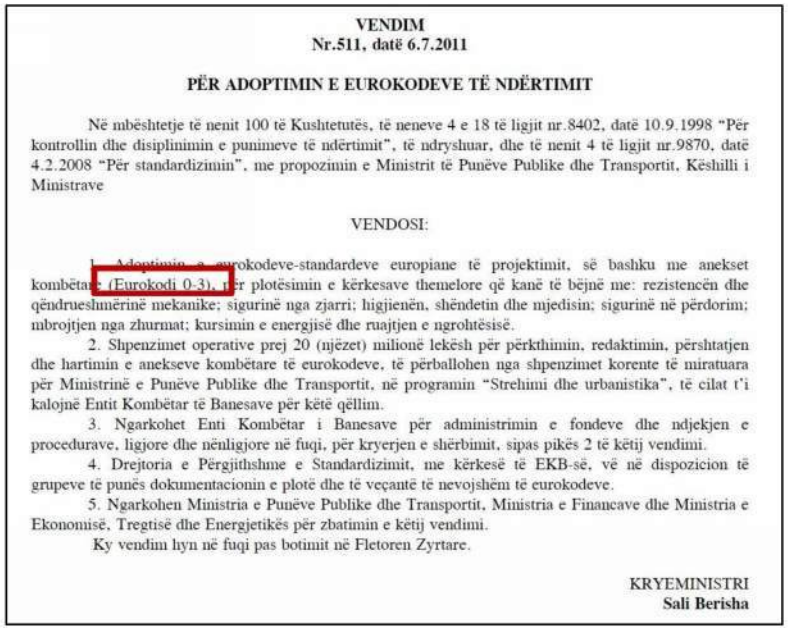
  SSH EN 1990;

  SSE EN 1991, all parts

  SSE EN 1992, all parts

  SSE EN 1993, all parts

- Currently: voluntary adoption since KTP-78 must still be followed



VENDIM
Nr.511, datë 6.7.2011

PËR ADOPTIMIN E EUROKODEVE TË NDËRTIMIT

Në mbështetje të nenit 100 të Kushtetutës, të neneve 4 e 18 të ligjit nr.8402, datë 10.9.1998 "Për kontrollin dhe disiplinimin e punimeve të ndërtimit", të ndryshuar, dhe të nenit 4 të ligjit nr.9870, datë 4.2.2008 "Për standardizimin", me propozimin e Ministrit të Punëve Publike dhe Transportit, Këshilli i Ministrave

VENDOSI:

1. Adoptimin e eurokodeve-standardeve europiane të projektimit, së bashku me anekset kombëtare (Eurokodi 0-3), për plotësimin e kërkesave themelore që kanë të bëjnë me: rezistencën dhe qëndrueshmërinë mekanike; sigurinë nga zjarri; higjienën, shëndetin dhe mjedisin; sigurinë në përdorim; mbrojtjen nga zhurmat; kursimin e energjisë dhe ruajtjen e ngrohtësisë.
2. Shpenzimet operative prej 20 (njëzet) milionë lekësh për përkthimin, redaktimin, përshtatjen dhe hartimin e anekseve kombëtare të eurokodeve, të përballohen nga shpenzimet korente të miratuara për Ministrinë e Punëve Publike dhe Transportit, në programin "Strehimi dhe urbanistika", të cilat t'i kalojnë Entit Kombëtar të Banesave për këtë qëllim.
3. Ngarkohet Enti Kombëtar i Banesave për administrimin e fondeve dhe ndjekjen e procedurave, ligjore dhe nënligjore në fuqi, për kryerjen e shërbimit, sipas pikës 2 të këtij vendimi.
4. Drejtoria e Përgjithshme e Standardizimit, me kërkesë të EKB-së, vë në dispozicion të grupeve të punës dokumentacionin e plotë dhe të veçantë të nevojshëm të eurokodeve.
5. Ngarkohen Ministria e Punëve Publike dhe Transportit, Ministria e Financave dhe Ministria e Ekonomisë, Tregtisë dhe Energjetikës për zbatimin e këtij vendimi.

Ky vendim hyn në fuqi pas botimit në Fletoren Zyrtare.

KRYEMINISTRI
Sali Berisha

Second Stage of Eurocode Adoption

Ref: Rikard Luka: "Present Status of Eurocodes in Albania", 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Summary of Building Codes

- In 2016: Third Stage of Eurocode Adoption
- 2016 Albanian Standard (not code):

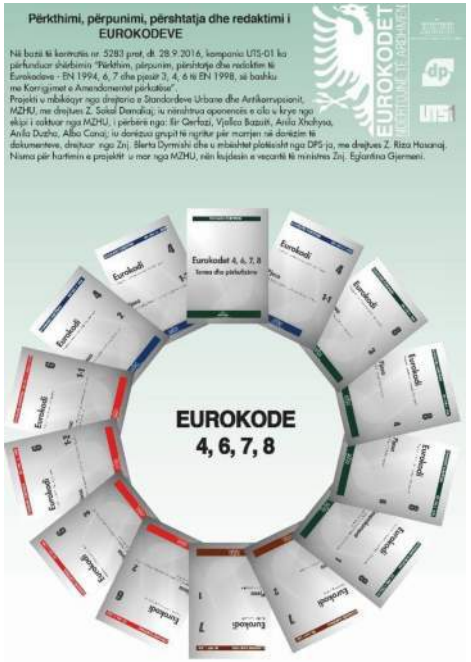
  SSH EN 1994;

  SSE EN 1996

  SSE EN 1997

  SSE EN 1998, parts 3, 4, 6

- Currently: voluntary adoption since KTP-78 must still be followed.

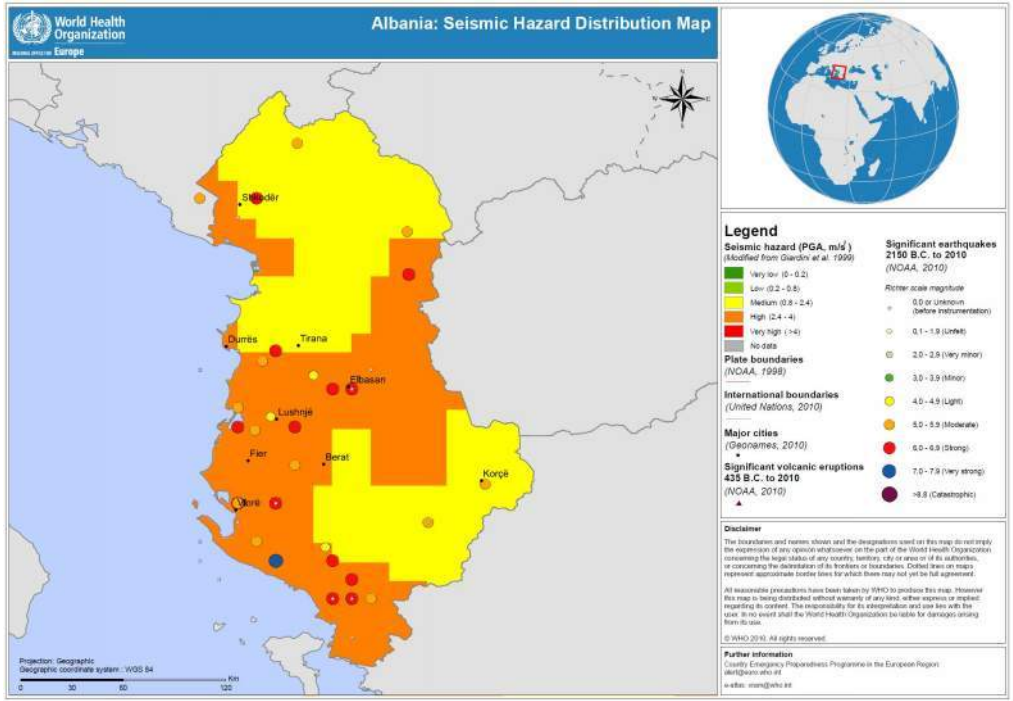


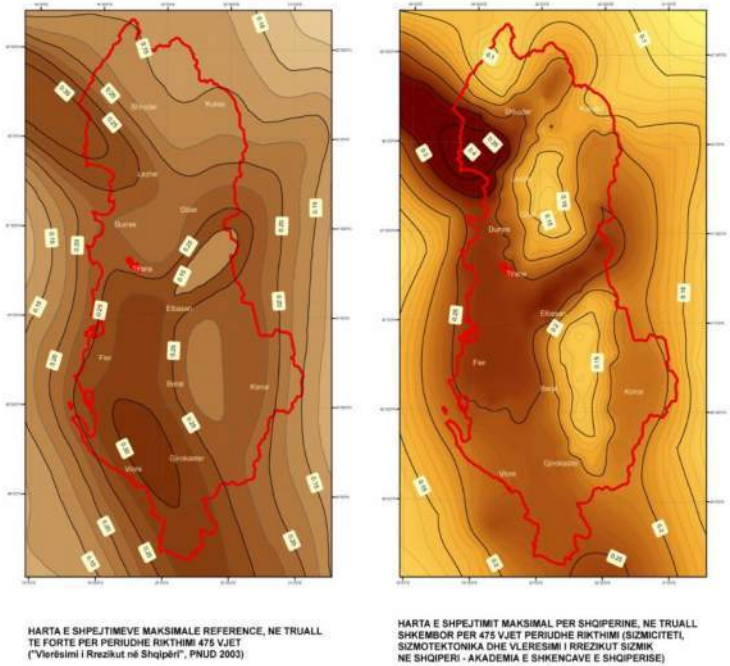
Third Stage of Eurocode Adoption

Ref: Rikard Luka: "Present Status of Eurocodes in Albania", 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Summary of Building Codes

Seismic maps developed 2003, PGA in most active regions 0.24 - 0.4g. Maps not required to be used in design.





HARTA E SHPEJTIMEVE MAKSIMALE REFERENCE, NE TRUALL TE FORTE PER PERIUDHE RIKTHIMI 475 VJET ("Vlerësimi i Rrezikut në Shqipëri", PNUD 2003)

HARTA E SHPEJTIMIT MAKSIMAL PER SHQIPERINE, NE TRUALL SHKEMBOR PER 475 VJET PERIUDHE RIKTHIMI (SIZMICITETI, SIZMOTEKTONIKA DHE VLERESIMI I RREZIKUT SIZMIK NE SHQIPERI - AKADEMIA E SHKENCAVE E SHQIPERISE)

World Health Organization

Summary of Building Codes

- Seismic maps developed 2003, PGA in most active regions 0.24 - 0.4g (0.35g for Durresi)

Table 2. Hazard at 10%/50 year probability for selected Albanian cities and towns (%g).

City	Lat N	Lon W	Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
Tirana	41.33	19.83	77	58	28	9.6	32
Durresi	41.34	19.44	86	66	31	10.3	35
Elbasani	41.12	20.09	90	66	30	10.1	38
Shkodra	42.07	19.52	75	57	28	9.3	30
Vlora	40.47	19.48	88	69	33	11.0	36
Fieri	40.73	19.57	86	68	32	10.8	35
Korca	40.62	20.79	99	75	34	11.0	41
Kukesi	42.08	20.43	81	58	26	8.6	34
Burreli	41.63	20.02	48	40	20	7.6	18

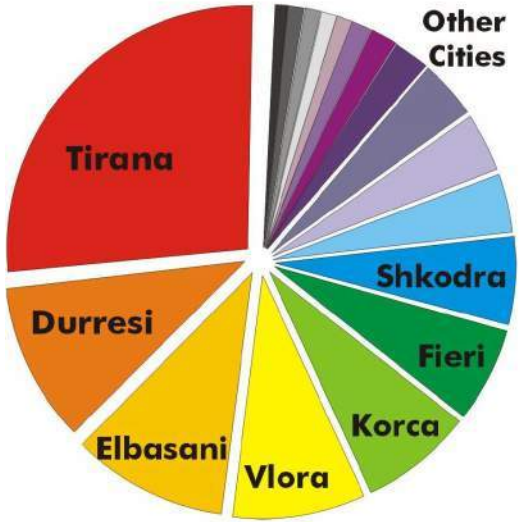


Figure 11. Urban seismic risk in Albania

- Durresi is second highest risk in the country, considering PGA, urban stock size and population

Aliaj et al, Probabilistic Seismic Hazard Maps for Albania, 13th WCEE, Vancouver 2004

References

Aliaj et al, Probabilistic Seismic Hazard Maps for Albania, 13th WCEE, Vancouver 2004

Rikard Luka: “Present Status of Eurocodes in Albania”, 2018 Workshop, the Way forward of Eurocode Implementation in the Balkans

Topic: Aftershocks

VERT Phase Response for:
M6.4 Albania Earthquake

Summary of Aftershocks

- Around 523 aftershocks have been recorded in the 24 hours post the M6.3 earthquake that hit Albania on Tuesday, 26 November 2019.
- The Department of Seismology at the Geo-Sciences Institute stated that 4 aftershocks were of a magnitude higher than 4.5. They added that 7 aftershocks were of a 4–4.5 magnitude, and 17 more between 3.5–3.9 magnitude.
- Approximately, 27 residential buildings and 163 houses were damaged to the degree that they are uninhabitable [1]

Map depicting aftershocks centred around Durres and Tirane [1]

Summary of Aftershocks

Series of aftershocks [M>4] that occurred on 2019-11-26 [2]

M 4.7 - 21km N of Durres, Albania (17:19:13 (UTC))

M 4.2 - 19km WNW of Mamurras, Albania (15:11:56 (UTC))

M 4.9 - 13km W of Mamurras, Albania (13:05:00 (UTC))

M 4.4 - 12km N of Durres, Albania (12:14:13 (UTC))

M 4.8 - 21km WSW of Mamurras, Albania (07:27:02 (UTC))

M 5.4 - 22km W of Mamurras, Albania (06:08:22 (UTC))

M 5.3 - 9km WNW of Vore, Albania (03:03:00 (UTC))

M 5.1 - 6km NNW of Shijak, Albania (02:59:24 (UTC))

Summary of Aftershocks

Series of aftershocks [M>4] that occurred on 2019-11-27 [2]

M 4.2 - 12km N of Durres, Albania (23:02:49 (UTC))

M 4.4 - 13km N of Durres, Albania (22:51:24 (UTC))

M 4.5 - 16km N of Durres, Albania (22:50:15 (UTC))

M 4.3 - 21km NNW of Durres, Albania (22:19:00 (UTC)

M 4.5 - 20km W of Mamurras, Albania (17:11:04 (UTC))

M 5.3 - 19km WSW of Mamurras, Albania (14:45:24 (UTC))

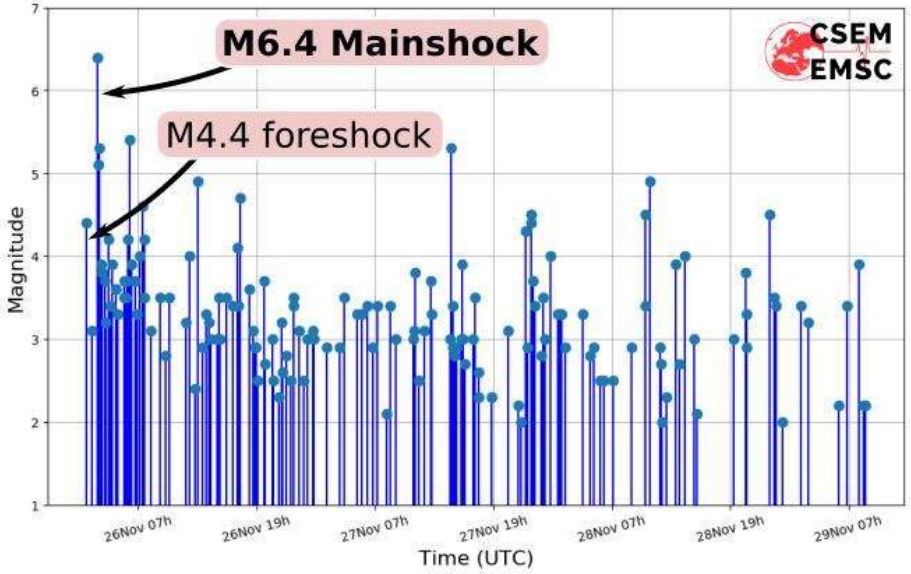
M 4.1 - 16km W of Mamurras, Albania (11:03:35 (UTC))

Location of earthquake sequence in Albania and in Bosnia and Herzegovina 7 hours after the mainshock [3]

Summary of Aftershocks

Series of aftershocks [M>4] that ccurred on 2019-11-28 [2]

M 4.6 - 2km N of Shijak, Albania (23:00:43 (UTC))
M 4.4 - 1km NW of Shijak, Albania (20:33:24 (UTC))
M 4.9 - 23km W of Mamurras, Albania (10:52:42 (UTC))
M 4.5 - 22km WSW of Mamurras, Albania (10:25:05 (UTC))



Magnitude distribution in time of seismic events within 100 km of the mainshock [3]

Collapse likely aggravated by aftershocks

Dwelling early in the morning after the main shock in Kënetë, Durrës [4]

Dwelling totally collapsed after several aftershocks in Kënetë, Durrës [4]

Damages due to aftershocks

M5.3 aftershock 2019-11-27 14:45:25.6 UTC: 4-storey building collapses in Durrës [5]

M4.9 aftershock, 2019-11-28 10:52:41.9 UTC caused new damage to the hospital in Durrës [6]

2019-11-28 aftershocks aggravated non-structural damage to buildings in Tirana [7]

Population awareness of earthquakes

- The same area was affected by a M5.6 earthquake on September 21st 2019 which caused injuries and widespread nonstructural damage and panic in Tirana and Durrës [8,9]
- Following the September 21st and especially the November 26th earthquake, considerable media attention has been given to seismology experts and structural engineers, contributing towards the education of the population.
- The large number of aftershocks with a relatively large magnitude caused panic to the population and many left Durrës for safer cities [10]

References

[1]https://exit.al/en/2019/11/27/albania-earthquake-sent-523-aftershocks-in-24-hours/
[2] https://earthquake.usgs.gov/
[3]https://www.emsc-csem.org/Earthquake/262/M6-4-ADRIATIC-SEA-on-November-26th-2019-at-02-54-UTC
[4] https://www.youtube.com/watch?v=TjSA2nulJgs&feature=emb_err_watch_on_yt
[5]https://balkanweb.com/lajmi-i-fundit-shtohet-paniku-ne-durres-shembet-banesa-4-kateshe-nga-termeti-i-forte-i-pasdites-se-sotme/
[6] https://tvklan.al/demtime-ne-murin-e-urgjences-se-spitalit-te-durresit/
[7]http://www.panorama.com.al/fotot-peson-carje-nje-pallat-tek-fresku-ne-tirane-banoret-ne-panik-lene-shtepite/
[8] https://edition.cnn.com/2019/09/21/europe/earthquake-albania/index.html
[9] https://balkanweb.com/fotolajm-e-frikshme-pallati-ne-tirane-cahet-mespermes-nga-termeti/
[10]https://balkanweb.com/qyteti-3-mije-vjecar-eshte-ringritur-disa-here-reportazhi-frika-nga-termetet-zbraz-lagjet-e-durresit/

Topic: Hospitals

VERT Phase 1 Response for:
M6.4 Tirana Earthquake
Albania

Summary of Hospitals

- No immediate reports of damage to or negative impact to operations of hospitals.
- “Medical facilities coping well in Albania following earthquake” [2]
- A hospital in Lac was damaged and patients were evacuated [3]
- Durres hospital suffered damage (see subsequent slides), hospital still open
- To cope with the large numbers of injured people, a number of private hospitals including Hygeia, Spitali Amerikan and Polyklinika Doctors Hospital have opened their doors to those hurt in the quake. They are treating people for free to help out the overburdened state hospitals [6]

Durres Hospital

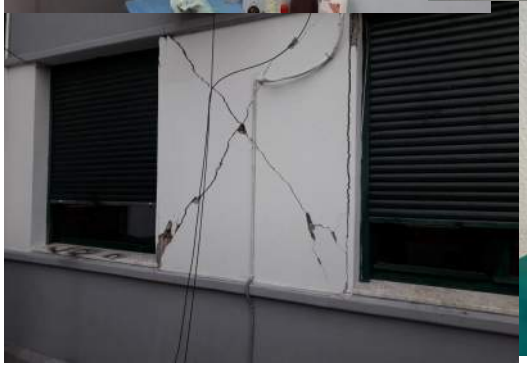
- "The 4.9 magnitude earthquake a few minutes ago caused damage to the wall of the Durres Hospital Emergency wing. The news is confirmed by hospital doctors who say the plaster has been knocked down and the wall damaged. Fortunately, no injuries. Police have blocked off access to the damaged area." [1] (google translate with edits)
- *“ At Durres Hospital, Emergency is functioning normally. Part of the building is damaged and a preliminary assessment is currently underway. The emergency is continuing to function normally where there are currently 18 cases of panic attack and no serious cases ”,* Minister Manastirliu said (28 November). [5]

Durres Hospital [1]

Durres Hospital

Sampling of damage to Durres Hospital documented 28 Nov by Chiara McKenney in the field [4]

“The emergency wing of Durres Regional Hospital (which was damaged by main shock) became more damaged during an aftershock today. When I visited the hospital today (a few hours after aftershock), they were planning to close that section of the hospital soon due to the damage. Two story building, RC frame with hollow clay brick. Hollow bricks did not fall outward, but the X cracking got more severe, making the building more vulnerable to further aftershocks.” [4]



References

1. https://tvklan.al/demtime-ne-murin-e-urgjences-se-spitalit-te-durresit/
2. http://www.euro.who.int/en/health-topics/emergencies/pages/news/news/2019/11/medical-facilities-coping-well-in-albania-following-earthquake
3. https://twitter.com/HumanityRoad/status/1199377399215001601
4. https://photos.google.com/share/AF1QipN8MqVTtq9MVEcBuAr4jXsDmvkv1YNiYxlGMXr2AjsUbYHv5DEksi-nnM6vK12Wxw?key=cFRkM2xBZVB4UnlzQWtoSV8xWE4wb0xvbTZ3cjVB
5. https://tvklan.al/manastirliu-inxhinieret-po-vleresojne-demet-ne-spitalin-e-durresit/
6. http://www.tiranatimes.com/?p=143584

Topic: Schools

VERT Phase 1 Response for:
M6.4 Tirana Earthquake
Albania

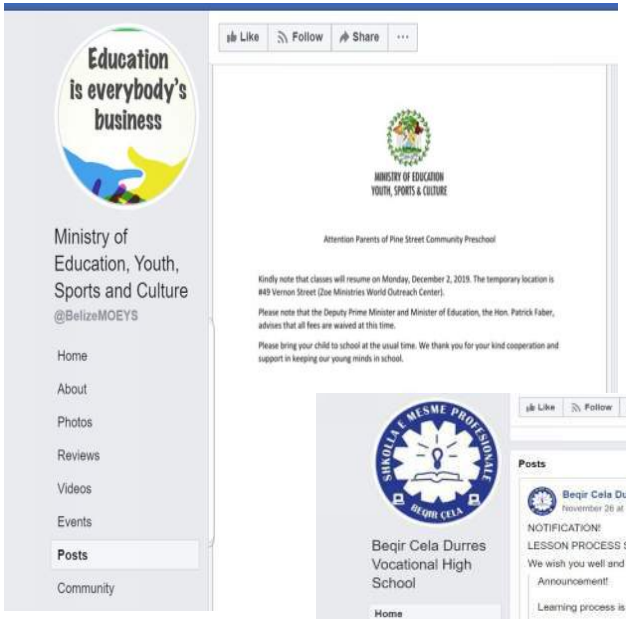
Timeline and Ministry of Education, Sport, and Youth of Albania (MoESY)

- There were no immediate reports of damage to schools. Earthquake occurred at night and schools did not open the following day.
- MoESY of is the highest executive authority of pre-university education management has the mission of the implementation of national educational policies, outlined by the Council of Ministers, and the continuous improvement of the quality of the educational service for all Albanian citizens.
- The Ministry of Education,Sports and Youth sets the curricula, administrative and ***infrastructure standards***, and drafts the policies of professional development.

Schools - Timelines

- **Nov 25:** “The Ministry of Education, Sport and Youth (MoESY) announces that all schools in ***Tirana, Durres and Lezha*** will be suspended today.”
- **Nov 25:** MoESY “No damage is reported in ***Fier***, but classes are suspended due to concerns citizens have experienced.”

Schools - Timelines



[3]

[11]

Schools - Timelines

- **Nov 26:** All schools in "territory" suspended from teaching
- **Nov 26:** MoESY - "We are on the ground to verify the state of schools and gyms. Those that are sustainable, in a coordinated manner by emergency staffs, will be made available to families who have suffered serious damage to their homes."
- **Nov 27:** MoESY suspended teaching in all schools, kindergartens and kindergartens around the country (including non-public ones) on November 27, 2019 "so that families can stay together and face the situation by solidarizing with those who were most affected by this tragedy."
- **Nov 28 & 29:** ***School Damage Assessment:*** Volunteer construction engineers from The Municipality of Prishtina and the Public Housing Enterprise SH. A. Pristina (Kosovo) are assisting the Albanian Ministry of Education, Sports, and Youth (MoESY) with "school and home vetting." - Nov 28&29
- **Nov 28 & 29:** Albania National Holidays, Schools Closed
- **Nov 30:** The Ministry of Education, Sport and Youth (MoESY) announces that "classes will resume on Monday, December 2, 2019." [3]
- **Dec 1**: Based on a news report [12] there are 23 damaged schools in Tirana; 16 damaged schools in Durres; 10 damaged schools in Lezhe.

Administrative Data # Students in Albania

Të regjistruar në arsim						
Enrolled in education						
						numër/number
Viti shkollor / akademik	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**School / academic year**
Të regjistruar në arsim						**Enrolled in education**
Gjithsej:	**748,488**	**704,779**	**677,818**	**652,592**	**641,161**	**Total:**
Në Kopshte	82,494	82,623	81,194	81,026	78,942	In Kindergatens :
Në arsimin 9 vjeçar:						In basic education:
Në fillore	188,371	179,564	174,836	170,861	167,104	*In primary*
Në ciklin e lartë të arsimit bazë	175,037	163,935	153,264	148,810	139,426	*In Lower secondary*
Në arsimin e mesëm:	140,042	130,380	127,114	120,062	116,646	In Upper secondary:
Gjimnaz dhe Social-Kulturor	117,241	108,956	106,133	99,457	95,359	*Gymnasium & Socio-Culturor*
Profesional	22,801	21,424	20,981	20,605	21,289	*Vocational*
Në arsimin e lartë*	162,544	148,277	141,410	131,833	139,043	In Tertiary*
*Të dhënat e Isced 4 janë riklasifikuar në nivelin Isced 5.						
Burimi i informacionit: Të dhënat administrative nga Ministria e Arsimit Sportit dhe Rinisë						
*Isced 4 data is reclassified to Isced level 5.						
Source of information: Administrative data from Ministry of Education Sport and Youth						

http://www.instat.gov.al/en/themes/labour-market-and-education/education/#tab4

Administrative Data # Students in Durres

Schools in Durres - Public Schools

(unknown which are undamaged or damaged)

- Gjergj Kastrioti High School
- Naim Frasheri High School
- Leonik Tomeu High School
- Dom Nikoll Kaçorri High School
- Olsi Lasko High School
- Benardina Qerraxhia Sports Mastery
- Hysen Çela Technological High School
- Beqir Çela Professional High School

Schools in Durres - Private Schools

(unknown which are undamaged or damaged)

- ARBERIA High School
- ARISTOTELI High School
- ARSAKEIO High School
- CELESI MAGJIK High School
- DON BOSKO High School
- DRITA E DITURISE High School
- EKONOMISTI High School
- ERNEST KOLIQI High School
- EUROLINGUA High School
- EUROVIZION High School
- FAIK KONICA High School
- FLABINA High School
- GAUSS High School
- LINZ High School
- GUINESS High School
- HARRY FULTZ High School
- KRISTAQ RAMA High School
- M.AKIF.DJEM High School
- M.AKIF.VAJZA High School
- MEDRESE MAHMUD DASHI High School
- MERIDIAN+ High School
- MESONJTORJA High School
- MIST High School
- Turgut Özal College
- Top School
- Albanian College Durres

Schools in Durres - Private Schools

(unknown which are undamaged or damaged)

- MREKULLIA High School
- NILS BOR High School
- NJUTON High School
- NOBEL High School
- QELLIMI I JETES High School
- RREZE DRITE High School
- SAADI High School
- TIRANA JONE High School
- TURGUT ÖZAL College
- UNITED ALBANIAN COLLEGE
- UNIVERS High School
- VELLEZERIT KAJTAZI High School
- Wilson High School (Tirana)
- WISDOM High School
- Vinçens Prendushi Primary & High School
- Frymë Dashurie Primary & High School
- Mihal Ekonomi Primary & High School
- Iliria Primary & High School
- Kasa Primary & High School
- Konica Primary & High School
- Migjeni Primary & High School
- Pavaresia Primary & High School
- Rilindja High School

School Building in Thumanë

- This school building in Thumanë will be demolished on 11/30.
- School is a masonry structure
- Structural damage is shown to the walls along the shortest direction.
- No news report was found of this damage;

This report was obtained by Markel Baballeku on site. [Text (edited) and photos reported by VERT member Brisid Isufi, 29 nov, 16:41 UTC]

Shkolla 9-vjeçare “Kongresi i Luchnjes” (Tirana) [12]
YouTube video from news agency in Albania

Screenshot 0:06

Screenshot 2:53

Screenshot 0:18

Screenshot 0:23

Screenshot 1:11

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Topic: Housing (single-family homes)

VERT Phase 1 Response for:
M6.4 Albania Earthquake

Summary of Housing

- Some 70 houses were damaged in Floq and the nearby village of Dvoran, the Defence Ministry said. A resident of the village of Floq told that the roof of his house had collapsed over two rooms. [1]
- Half of the 100 damaged house were abandoned old structures, the Defence Ministry said [1]
- Albanian Prime Minister Edi Rama said “The quake damaged more than 700 houses in Durres, destroyed 12 more and left nearly 200 apartment buildings with cracks and fissures” [4]
- Preliminary figures showed that more than 1,465 buildings in the capital Tirana suffered serious damage, in addition to about 900 in nearby Durrës [8]

Summary of Housing

Damaged masonry houses
[9]

Confined masonry damaged residential building
Photo: Petros Giannakouris, AP [3]

Summary of Housing

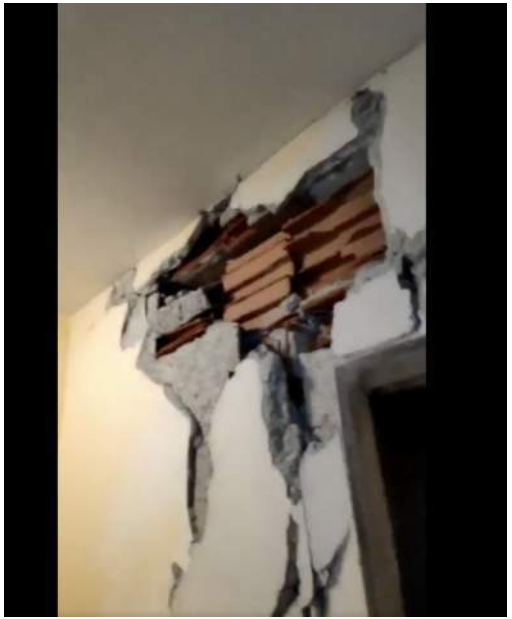
A collapsed building (probably confined masonry) in Durres Photo: Hektor Pustina, AP [3]

Toppled apartment buildings
Photo: Hektor Pustina, AP [2]

Summary of Housing

Significant damage in two-story house Photo: Euronew Albania [5]

Damaged masonry wall Euronews Albania - Video recording [6]



Moderate to major damage inside of an apartment building - Video recording [7]

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Topic #7: Geotechnical Damage

VERT Phase 1 Response for:
M6.4 Albania Earthquake

Summary of Geotechnical Damage

Ground failure and liquefaction at Jubë [1], [2], [3]

Liquefaction at Jubë [2]

Summary of Geotechnical Damage

Ground failure [2]

Liquefaction [2]

Location [2]

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Topic: Lifelines

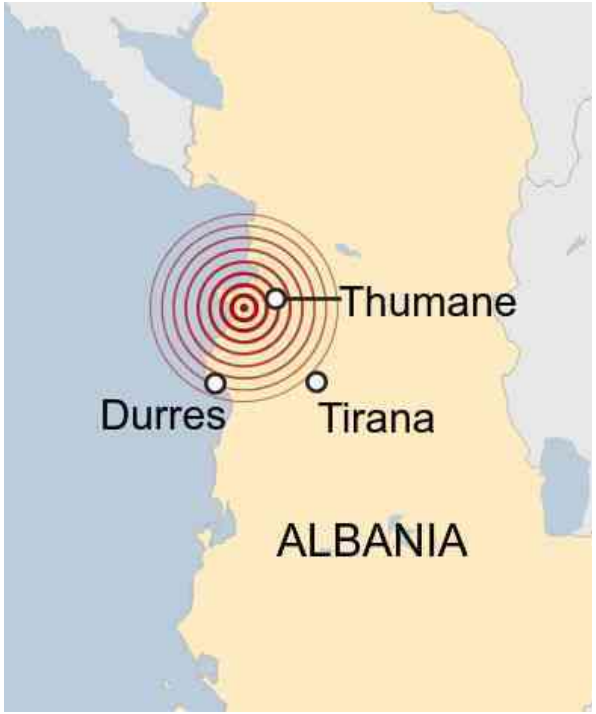
VERT Phase 1 Response for:
M6.4 Albania Earthquake

Lifelines - Transportation and Sanitation

- Tirana’s Airport cancelled flights due to building damage [1]
- There were reports of blocked roads due to debris, in north-western Lezhë, that caused accidents [1]
- No apparent damage to sanitation services in the affected major cities [12]

Lifelines - Electric Power

- In Dürres, there was a power outage after the earthquake [2]. An electrical pole was reported damaged by the earthquake in the village of Rashbull, Dürres. Flames were spotted on the electrical pole due to component failure. [8]
- Power outages were reported in several neighborhoods in Tirana following the mainshock [3]
- It was reported that power distribution station was damaged by the earthquake in Thumane. The power electricity was restored later in the day (Tuesday, local time). [3]



Earthquake caused power outages in the city of Thumane, Durres and Tirana [9]

Lifelines - Communication, Gas, and Water Lines

- It was reported that there is no significant disruption on communication (land and mobile) lines [4]

- Gas lines are not typical for residential housings in Albania.
- Limited disruption on gas line or gas related damages has been reported, except for a case in which government has removed gas storage tanks from hotels, restaurants, and gas stations for safety consideration [5]

Residents were removing water storage tanks [10]

Lifelines - Communication, Gas, and Water Lines

- There was no report on major disruption on water lines to residential housings or buildings.
- Many residents keep their water in storage tanks at an elevated level (e.g. roof level). These water storage tanks had imposed a threat to residents due to their collapsed or overturned vulnerability during the earthquake [6].
- It was also reported that residents had started removing those tanks because they were considered unsafe [7].
- There is water outage in small villages of Durres [11]

Residents were removing water storage tanks [10]

Overview & and how it affected various regions

Lifeline	Status
Electric power	Mild - moderate initial disruption Power outages were reported at three major cities: Durres, Thumane, and Tirana. A power station was damaged in Thumane. No specific recovery time mentioned in the news, but it was mentioned that the electric power was resumed operation later in the day after the mainshock (Thumane)
Gas	No major disruption on gas lines (not typical in Albania). Gas storage tanks were removed from hotels, restaurants, and gas stations due to safety considerations.
Water	No major disruption on water lines nor sanitation infrastructure. Water storage tanks located at an elevated level has posed a threat to residence and removed from residentials.
Telecommunications/Internet	No major disruption on telecommunication (land and mobile).
Oil	No report
Airport	Flight cancellations were reported due to infrastructure damage after the mainshock
Port	No report
Public Transit	No report

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Topic: Emergency Response

VERT Phase 1 Response for:
M6.4 Albania Earthquake

Emergency Response

- Albanian, Serb and Montenegrin crews came to the site for rescue missions [1].
- Greece has sent 16 engineers from the country's natural disaster relief agency to help in reconstruction on Friday [1].
- The European Union pledged further assistance to Albania's needs [1].
- Search and rescue operations were officially declared terminated on Friday 29 November [2].
- Structural engineering teams from Greece, Italy, France, and Switzerland are currently in the field supporting the damage assessment [2].
- Italy, Greece, Montenegro, North Macedonia, Kosova, Serbia, Turkey, Romania, France, Croatia, Israel, Switzerland, and the European Union's civil emergency units arrived to help [3].
- Red Cross also sent a team specializing in search and rescue, camp management, and logistics [4].

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Topic: Engineering Culture

VERT Phase 1 Response for:
M6.4 Tirana Earthquake
Albania

Overview of residential building typology and materials

According to Novikova et al [1]:

	1. Detached houses Dtch	2. Semi-detached houses Sem_Dtch	3. Row (or terraced) houses Row_Terr	4. Multi-family apartment Mult_Fam_Ap
A before 1960	 Dtch_20–60	 Sem_Dtch_20–60	 Row_Terr_...60	 Mult_Fam_Ap...60
B 1961–1980	 Dtch_61–80	 Sem_Dtch_61–80	 Row_Terr_61–80	 Mult_Fam_Ap_61–80

- Until 1990, masonry was the most commonly used structural material for buildings [1,2].
- Concrete prefabricated buildings were also built after 1960 [1];

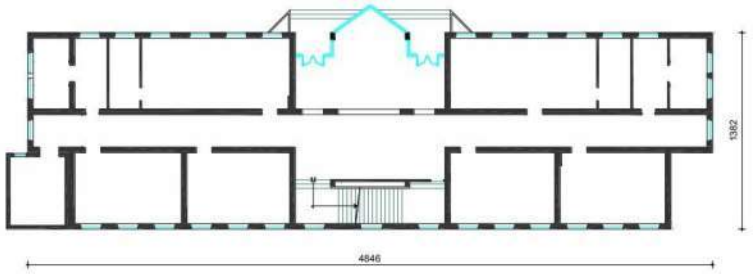
Overview of residential building typology and materials

According to Novikova et al [1]:

- Confined masonry started to be used after ~1980 [2];
- After 1990 and especially after 2000: reinforced concrete buildings are prevalent.

Workmanship, design and quality control

- During the communist era (before 1990) some masonry buildings were built based on “voluntary work” by relatively unqualified workers, including some collapsed buildings in Thumanë [3].
- For other buildings before 1990 (usually those considered more important), skilled workers and engineers were involved. Template structural designs were often used to build schools and other buildings [4]. The designs were exclusively prepared by a centralized institution [5];



Example of a template school design [4]

Workmanship, design and quality control

- According to [1]: “Only 7 percent of apartment buildings were constructed before 1960. The boom began after 1960, when large number of prefabricated buildings were erected during the communist era. The construction of apartment buildings slowed after 1990, but between 2001 and 2011 the rate more than doubled compared to the previous decade.”

- Albania's towns developed chaotically after the fall of communism in the 1990s. A lot of construction was done "without a building permit, without respecting rules... using non-standard materials", local architect Maks Velo told AFP. [6]

Workmanship, design and quality control

- During years 1990 – 2000: Design projects were decentralized (private companies and individuals started to design structures) [5];
- After ~2005: Structural designers use modern design codes (mostly Eurocode) on a voluntary basis. Parts of Eurocodes adopted as Albanian Standard in 2012 [5].
- Informality in construction in Durrës remained high [6].

A typical structure after 2000 in Tirana and Durrës (photo: Brisid Isufi, 2008)

Construction methods

Unconfined masonry building in Tirana (photo: Bledi Skora, 2019)

Confined masonry building in Tirana (photo: Bledi Skora, 2019)

Prefabricated building in Durres (photo: Chiara McKenney, 2019)

Construction methods

Multistorey buildings after 1990: predominantly reinforced concrete (moment resisting frames and shear walls).

Typical modern RC building under construction in Tirana (photo: Brisid Isufi, 2008)

Typical partition walls in new RC buildings (photo: Brisid Isufi, 2009)

RC building under construction in Tirana (photo: Brisid Isufi, 2008)

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