General info

This technical visit will allow to explore the town of L’Aquila and neighbouring areas of the Aterno river valley, ten years after the destructive $M_w$ 6.1 earthquake of April 6, 2009.

The one-day tour will start from the conference venue in Roma and end at the same location. The bus transfer from Roma (city centre) to L’Aquila by A24 motorway will take about 1 h 45 min (one way). The total duration of the tour will be about 12 hours, from morning to evening.

Itinerary and timetable (indicative)

Stops
Roma (departure 7:30 am) – L’Aquila – Onna – Campotosto – L’Aquila – Roma (return 7:45 pm)

Plan

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
<th>Time</th>
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<tr>
<td>Bus transfer from Roma to L’Aquila</td>
<td>1 h 45 min bus</td>
<td>7:30 – 9:15</td>
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<tr>
<td>Guided walking tour in the city centre</td>
<td>2 h 20 min walk</td>
<td>9:15 – 11:35</td>
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<tr>
<td>Visit of Basilica di Collemaggio</td>
<td>15 min walk</td>
<td>11:35 – 11:50</td>
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<tr>
<td>Visit of C.A.S.E. Project Bazzano</td>
<td>5 min bus + 15 min walk</td>
<td>11:50 – 12:10</td>
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<tr>
<td>Visit of Onna</td>
<td>5 min bus + 30 min walk</td>
<td>12:10 – 12:45</td>
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<tr>
<td>Lunch (restaurant near L’Aquila)</td>
<td>1 h 30 min incl. bus transfer</td>
<td>12:45 – 14:15</td>
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<tr>
<td>Bus transfer from L’Aquila to Campotosto</td>
<td>1 h bus</td>
<td>14:15 – 15:15</td>
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<tr>
<td>Tour of Campotosto lake (stops: Sella Pedicate dam, Rio Fucino dam, Campotosto village, Poggio Cancelli dam)</td>
<td>30 min bus + 1 h walk</td>
<td>15:15 – 16:45</td>
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<tr>
<td>Bus transfer from Campotosto lake to L’Aquila</td>
<td>1 h 15 min bus</td>
<td>16:45 – 18:00</td>
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<tr>
<td>Bus transfer from L’Aquila to Roma</td>
<td>1 h 45 min bus</td>
<td>18:00 – 19:45</td>
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L'Aquila

L'Aquila is located about 120 km east of Rome and is the capital city of the Abruzzo region, with a population of about 70,000 inhabitants. The town is sited at an elevation of about 700 m above sea level, in an intermountain valley (Aterno river valley) surrounded by the Apennines highest mountains (Gran Sasso – Corno Grande 2912 m a.s.l.). L'Aquila is an ancient town, founded in the 13th century. Despite a long-time history of strong earthquakes, that each time largely destroyed the previous urban layout (in particular in 1461, 1703 and 2009), L'Aquila still exhibits a notable architectural-historical heritage. The original medieval layer is testified by the ancient town walls, recently restored. Several oldest palaces and churches were characterized by a Renaissance style, while the Baroque and neoclassical styles prevailed in post-1703-earthquake reconstruction. Even the present emblem colours of the town have a strong link with earthquakes: in fact, after the 1703 event the previous civic colours (red and white, also present in the Collemaggio façade) were replaced by black (mourning) and green (hope).

The magnitude Mw 6.1 earthquake that stroke L'Aquila and the neighbouring areas on April 6, 2009 caused 309 victims, about 1,600 injured, over 65,000 homeless and huge economic losses, with widespread damage over an area of approximately 600 km². The so-called 2009 “seismic crater” includes the city of L'Aquila (MCS Intensity I = VIII-IX) and several villages of the middle Aterno river valley. A maximum MCS I = IX-X was experienced at Onna and Castelnuovo. Ten years later, the social and economic impact of this event is still intensely felt by the population and the stakeholders. Post-earthquake reconstruction in the L'Aquila “crater” involves public buildings, private housing and the architectural-historical heritage. Overall, it is recognized as one of the most impressive concentrations of construction works in the last decades (once defined as “the largest construction site in Europe”), supported by sizeable public funding.

Visitors will have the opportunity to observe the status of the reconstruction ten years after the 2009 earthquake. A guided walking tour through the old city centre will allow to discover the newly disclosed beauty of restored ancient buildings (Palazzo dell'Emiciclo, Palazzo Camoneschi) and churches (Santa Maria del Suffragio, San Bernardino), to walk nearby the construction sites of historic buildings subject to retrofit works (Palazzo Margherita, Palazzo del Governo), but also to stroll through sectors where the reconstruction has not yet started (a restricted access “red zone” still exists) and to observe the status of damaged buildings pending the restoration works (Palazzo Centi, Palazzo Carli, Santa Maria di Paganica, Scuola De Amicis).

Information on the geological and geotechnical characteristics of the area of L'Aquila, in particular in the city centre (shear wave velocity inversion, deep bedrock, low frequency amplification) will be provided during the tour, along with information on the main features of the 2009 earthquake (significant site effects), on microzonation studies and on post-earthquake reconstruction plans.

The walking tour will include a visit to the shallow cut-and-cover excavation works of the “smart tunnel” which is being constructed to host the new utility network (power, water, communication) serving the city centre and the nearby districts.

The visit will comprise a walk in the area near Via XX Settembre, which borders the southern part of the historic centre. Most buildings in this area have a 5-7 storey reinforced concrete structure and were built between 1950 and 1965. Several buildings collapsed or suffered severe damage during the 2009 earthquake. Post-earthquake forensic surveys reported that 135 victims – i.e. 44% of the total number of casualties caused by the earthquake over the whole “crater” – were concentrated in the collapse of 11 buildings located in this area. One of these buildings was “Casa dello Studente”, a student dormitory of the University of L'Aquila, that is known as a symbol of the 2009 L'Aquila earthquake. (L'Aquila is a university town; 55 students were among the victims of the 2009 earthquake, other 2 students died in Amatrice in 2016). The huge concentration of damage within this area created speculation for both poor design and construction techniques of the buildings, also related to inadequate evaluation of the seismic action provided by the Italian building code in use at the time of their construction. In addition, possible significant amplification effects related to local subsoil conditions (shallow fine-grained residual deposits, underground cavities) were devised.

The walking tour will end with the visit to the Basilica Santa Maria di Collemaggio. This important catholic church, founded in the 13th century, contains the most ancient Holy Door in the world and hosts every year on August 28-29 a unique Jubilee (Perdonanza Celestina), a penitential observation devised by Pope Celestine V, who is buried here. Since its construction, started in 1287, the Basilica was damaged by several earthquakes (1315, 1349, 1456, 1461, 1703 – the most severe, 1915, 1958 and 2009). Parts of the structure of the Basilica were seriously damaged by the 2009 earthquake. While the beautiful Romanesque façade remained intact, the cupola, the transept vaults and the arches collapsed. A challenging restoration project of the Basilica, combining innovative structural technology with heritage conservation requirements, was funded by Eni S.p.A. (the first Italian oil & gas company) and completed in December 2017, when the church was reopened to the public. A monitoring system, composed of a network of sensors (accelerometers, crackmeters, tilmeters) connected to a control unit, was installed to monitor the dynamic and static structural behaviour of the building during and after the restoration works.
L'Aquila – Map of reconstruction and "red zone" in the city centre in March 2019 [source: Comune dell'Aquila, www.comune.laquila.gov.it]
C.A.S.E. Project

Starting from the city centre, the tour will continue with the visit to one district of the C.A.S.E. Project (Bazzano). The C.A.S.E. Project is an impressive temporary housing program launched by the Italian Government in the aftermath of the 2009 earthquake to host 15,000 homeless people in L'Aquila, pending the rebuilding of their homes, in addition to some thousands hosted in small temporary prefab houses in nearby villages. The acronym C.A.S.E., which in Italian sounds like H.O.U.S.E.S., stands for “Complessi Antisismici Sostenibili Ecocompatibili” (sustainable environmentally friendly earthquake-resistant compounds). The project comprised 185 buildings provided with seismic base isolation systems, constructed in just 8 months in 19 areas of the municipality of L'Aquila. The emergency scenario imposed very strict time constraints for decisions on reconstruction. Few weeks after the mainshock, the Civil Protection Department identified about 20 candidate sites. The final C.A.S.E. Project sites were selected taking into account their proximity to existing inhabited districts damaged by the earthquake, after assessing their suitability regarding seismic, hydraulic and geological safety conditions. These buildings were conceived to be seismically isolated. A task force of the Italian Geotechnical Society (AGI) was committed to investigate several of such sites by in situ seismic techniques and by cyclic/dynamic laboratory testing. The C.A.S.E. compounds extend over an area of 1,600,000 m², including block surfaces (427,615 m²), urbanization works (roads, car parks) and landscaped areas (800,000 m²), which occupy 50% of the total extension. A total of 4,449 apartments were made available to the population. The habitable surface of a single block, resting on 40 seismic isolators, is 1,800 m². Each block includes 24 apartments, with a capacity for housing 70/80 people, and over 30 parking spaces. A total number of 7,368 sliding pendulum seismic isolators were used in the C.A.S.E. Project. This was the first time in Italy that they have been used so extensively for a single project. The environmental sustainability was achieved by providing the buildings with energy-saving facilities (solar energy panels, photovoltaic panels, rainwater collecting systems). Most of the buildings are classified in the highest energy efficiency class. The total cost of the project was about 800 million euro, largely funded by the European Union integrated by public Italian funding and private donation. At present (June 2019) the C.A.S.E. Project hosts about 8,000 residents. Other ~2,000 are hosted in small prefab houses in nearby villages. As the reconstruction proceeded, many of the original residents of the post-earthquake emergency period were progressively replaced by other people, according to the social housing policy adopted by the municipality of L'Aquila.
L’Aquila – The C.A.S.E. Project. (a) Location of the 19 C.A.S.E. Project districts. (b) Testing of seismic base isolators at Coppito 3 (October 2009). (c) The C.A.S.E. Project Assergi 2. [source (a) and (b): Dipartimento della Protezione Civile, www.protezionecivile.gov.it]
Onna

The village of Onna, located about 10 km east of L'Aquila city centre, is part of the municipality of L'Aquila. The village was built in the 12th century on alluvial and fluvial plain deposits on the left bank of the Aterno river, at an elevation of 580 m a.s.l.

Onna was almost totally destroyed by the 2009 earthquake, as still clearly visible by walking through the village. The village is about 12 km far from the epicentre and overlies the fault rupture plane near its shallowest portion. Most of the buildings collapsed or were severely damaged. The small community of Onna payed the highest tribute to the 2009 earthquake in terms of human lives: 40 died, of a total population of about 350. For this reason Onna became an icon of that tragedy.

Post-earthquake field reconnaissance surveys in the Aterno river valley east of L'Aquila soon recognized significant differences in the damage distribution, even for similar types of buildings, creating speculation for both rupture directivity and site amplification effects. The highest macroseismic level in the “crater” (MCS I = IX-X) was assigned to the villages of Onna and Castelnuovo (the latter is about 25 km far from the epicentre). The villages of San Gregorio, Poggio Picenze and Villa San Angelo were also heavily damaged. Other villages (Monticchio, Fossa, Tussio, San Pio delle Camere, Barisciano) were less damaged.

Macroseismic histories indicate that Onna and Castelnuovo were affected by particularly strong intensities also during past earthquakes, in particular in 1461, as reported by 18th century chronicler Anton Ludovico Antinori:

“… Castelnuovo divenuto un mucchio di sassi, caduti anche i torrioni delle mura comuni colla morte di 28 persone ... Nella Villa di Onda nè tampoco restò casa impiedi ...”

(… Castelnuovo became a pile of stones, even the town wall towers fell down and 28 people died … In the Onda [now Onna] village no house was left standing …).

The markedly different level of damage observed in nearby villages located at a similar distance from the epicentre (village-to-village amplification), or within the same village (intra-village amplification), suggested that site effects related to different geological and topographic conditions may have played an important role in determining the damage distribution. An example is the comparison Onna vs. Monticchio.

Onna (MCS I = IX-X) is built on Holocene calcareous alluvial and fluvial deposits, composed of sand and gravel with interbedded clay and silt, more than 5 m thick, overlying Pleistocene silty-clay deposits. Monticchio (MCS I = VI), a village 1.3 km southwest of Onna, is built on a gentle slope at the toe of the northern part of Cavalletto mountain at about 600 m a.s.l. on Mesozoic limestone and Pleistocene silts. Onna was composed mainly of 2-3 storey unreinforced masonry structures, with only a few retrofitted structures and newer reinforced concrete residential structures. About 80% of unreinforced masonry structures collapsed. Reinforced concrete structures suffered minor or no damage. Monticchio suffered minor damage even in its unreinforced 2-3 storey masonry structures, and almost no damage in reinforced concrete residential structures. The elevated shaking intensity at Onna, as compared with the surrounding villages built on bedrock or stiffer alluvial debris, is attributed to site amplification effects of the valley fill relative to the surrounding bedrock.

Today most of Onna’s people still live in small prefab houses built nearby the village centre by the Civil Protection Department. This was the first temporary housing settlement in the crater, completed in September 2009.

During the second world war, in June 1944, the Nazi occupiers killed 17 civilians, mostly young people, in Onna. The plaque commemorating this massacre was undamaged by the earthquake. In symbolic compensation for the 1944 massacre, the German government vowed to focus aid and funding on this village. Germany contributed significantly to the rebuilding of Onna, starting with the construction of the new “Casa Onna” social centre one year after the earthquake, to the restoration of the church of San Pietro Apostolo (12th century).
Onna – Rescue operations and aerial view after the 2009 earthquake [source: Casa Onna documentation centre, www.onnaonlus.org]
Campotosto lake

After lunch the tour will move on to the upper Aterno river valley, heading to the Campotosto lake. This area comprises several municipalities (Montereale, Capitignano, Campotosto and others) that were damaged by the 2009 L’Aquila earthquake and also, but more severely, by the 2016-2017 Central Italy seismic sequence. The Campotosto lake is located approximately 40 km north of L’Aquila, at an elevation of about 1,300 m above sea level. It is the second largest water reservoir in Europe, in operation since several decades for production of hydroelectric power. It is impounded by two gravity concrete dams (Rio Fucino, 36.70 m high, and Sella Pedicate, 20.75 m high), and by one earth and rockfill dam (Poggio Cancelli, 27.30 m high). The reservoir and power plants are managed by Enel, the first Italian power production company. The Rio Fucino dam was constructed in two stages. The first one started in 1939 and was concluded in 1955. Subsequently the dam height was raised starting from 1966 until 1971. The lake resulted from submerging a plateau that was previously exploited for extraction of peat. The lake is formed mainly by the Rio Fucino river and by several streams and extends over an area of about 14 km², with a water capacity of more than 300 millions of m³ and a maximum depth of 30-35 m. It is composed by two branches (Mascioni and Campotosto, by the name of the nearshore villages) joined to form a V shape. An old bridge (Ponte delle Stecche) crosses the lake in its shortest point. The reservoir serves the hydroelectric power plants located in the Vomano river valley. The Campotosto lake is entirely located in the heart of the Gran Sasso e Monti della Laga National Park. The area is a protected reserve of "animal and plant population", created to preserve the local flora and fauna (many species of birds) of particular interest. The lake is known as a tourist attraction thanks to its wilderness and beautiful mountain views.

The tour of the lake will include stops at each of the three dams. A big concern about the dams is due to the presence of an important fault system, activated during the 2016-2017 seismic sequence, that will be illustrated during the visit along with technical information on the dams and the reservoir.

The SW slope of the Laga Mts. is affected by a set of normal faults NW-SE striking and SW dipping, located in between the 2009 and 2016 mainshocks. In 2009 and on 18 Jan 2017, the southernmost of these faults, commonly named the Campotosto fault, generated sequences of moderate seismic events, of up to Mw 5.5, four events of M 5-5.5 in the sole 18 Jan 2017.

A stop in the Campotosto village, located on the north shore of the lake, will permit to observe the devastation induced in this village by superimposition of damage induced by the 2009 L’Aquila earthquake and by the 2016-2017 Central Italy seismic sequence, particularly by the nearest four Mw > 5 shocks of 18 January 2017.
Campotosto village – Views of Campotosto in 2019, showing the cumulated damage induced by the 2009 and 2016-2017 earthquakes.

SW slope of the Laga Mts.

The Campotosto fault scarp

Campotosto and Amatrice faults – The Campotosto fault scarp.