Seismic response of traditional timber elements and roof structures: learning from the L'Aquila earthquake

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The timber roof structures and other timber elements, like floor slabs, in traditional buildings have a strong influence on the seismic response of the whole system. Various cases of timber roofs and elements in the L'Aquila region, in central Italy, and their contribution in the response to the earthquake that occurred in year 2009 are examined and discussed in this paper.
In the region, high-impact interventions at or near the roof, performed esplicitly for seismic strengthening, had been very popular in a recent past. Mostly, these consisted in adding strong concrete ring beams at the top of the supporting walls. In addition to the ring beam, a type of intervention recurrently found particularly in monumental buildings was the construction of concrete and brick slabs over the roof pents, increasing the load on the roof structure underneat. The aim was at stiffening the roof, obtaining a more pronounced diaphragm effect.
In some other cases, the timber structures of roofs had been improved without recurring to massive methods but by inserting light metal connectors and links; at times, substitution of decayed timber trusses had been performed with new similar trusses of the same material.
Many instances could be found of complete collapse of the roof and walls. However, well organized and connected roof trusses did not disassemble, and in better cases succeeded in constituting the desired link between facing walls. A favorable behavior of the whole building with a positive contribution coming from a truss roof structure was noted in many cases and could be ascribed to the good quality of the connection of tie-beams of the triusses to the walls. In these cases, according to the local carpentry tradition, the extremes of the tie-beam were regularly restrained with a simple timber key against the outer side of the wall.
Among other timber elements, timber ties had been abundantly used in the area in older construction. Their effect is very uncertain, specially because of the variability of details and of the difficulty in assessing their functioning. In a case discussed here, where the tie had become visible by the local collapse of the surrounding masonry, the necessary span length had been reached by aligning two timber elements with some overlapping and nails in shear. The deformability of the assemblage could not guarantee the intended linking effect.
Yet, depending on the details by which they are realized, and in particular on the quality of their connections, timber elements have demonstrated in many cases robustness resources beyond expectation. These qualities could be enhanced by suitable and low-impact strengthening techniques.

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