MiCHe project

UNIBO UNIT CONTRIBUTION

Case study: Modena Cathedral

Multi risk

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1 Multi-risk assessment

As mentioned in chapter 3 of part 2, the seismic risk has been here quantitatively compute with respect to direct losses L1 only, namely losses associated to structural damages. However, the same procedure can be easily extended to the other identified risks.

1.1 Summary of Fire risk analysis

As detailed in the final report of the Uniroma1 unit, the fire risk curve for the Modena Cathedral are carried out by adopting the scenario-based approach with reference to four fire scenarios (characterized by different intensity measure values). For each scenario the Cause-consequence (or "scenario") analysis is carried out by defining event-tree diagrams similar to the example one shown in Figure 2.3.10 below. The fire ignition point has been assumed as located in the loft zone above the Inlaid wooden "pontile" art masterpiece (Figure 2.3.11), the fire ignition is assumed to be caused by an electrical short circuit. In addition to the "No Damage" state, four damage/loss severity levels are identified (increasing in severity: 1) Limited damages to the roof; 2) Average damages to the roof wooden elements and partial loss of it; 3) Considerable damages to the roof wooden elements and loss of a considerable amount of it; 4) Complete loss of the wooden roof and significant damages to the content. Peculiarities of both the Low-Probability-High-Consequence (LPHC) events like fire, and of the heritage buildings (related to specific vulnerabilities to fire) are taken into account. As final result, the procedure produces a fire risk curve to a reference to a pre-defined return period Tr which, for fire hazard, has to be set to 50 years at least.

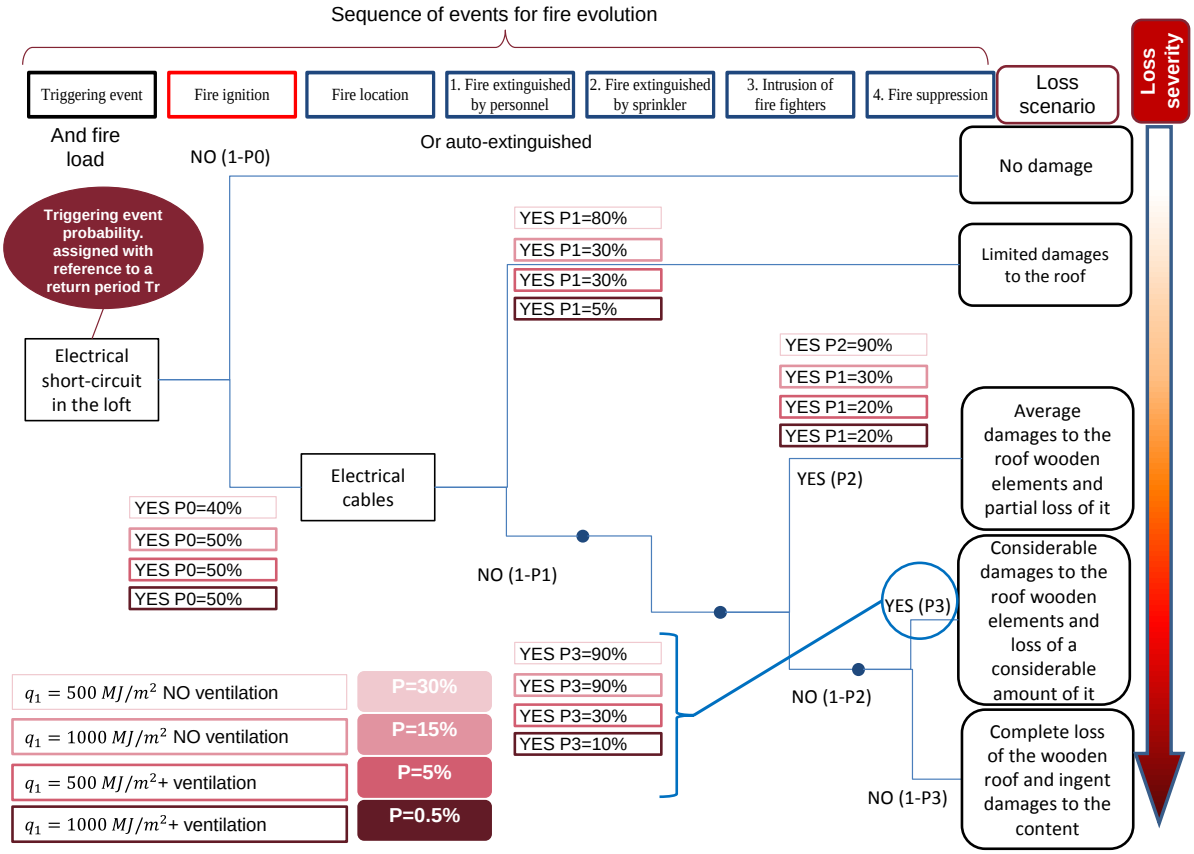


Figure 2.3.10: Example of event-tree diagram for fire risk analysis of the Modena Cathedral

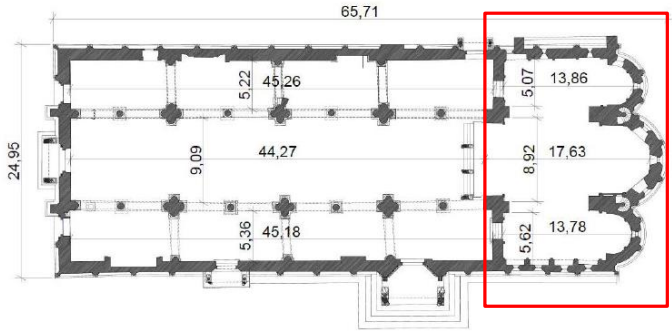


Figure 2.3.11: Fire ignition zone (loft compartment).

The obtained fire risk curve is shown in Figure 2.3.12, representing the complementary cumulative distribution function (CCDF) probability in the return period Tr=50 years, which is also interpolated by an exponential equation. If the loss severities are expressed in monetary terms, the risk curves constitutes the classical output of a single hazard risk analysis.

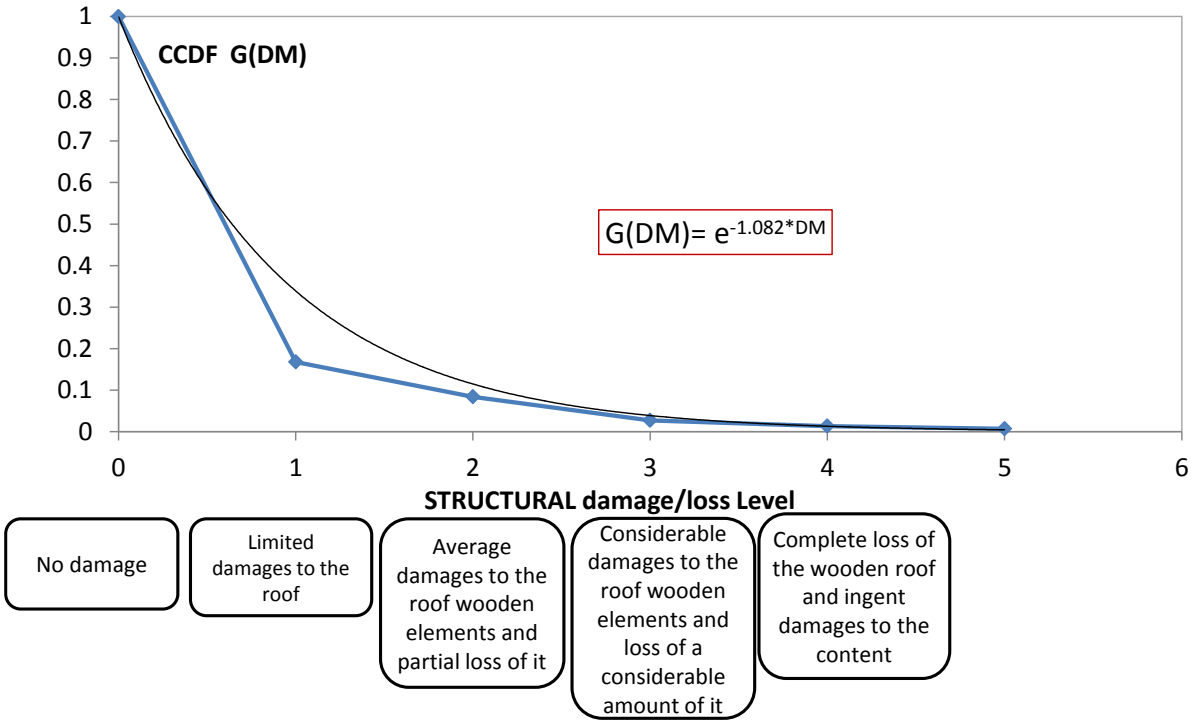
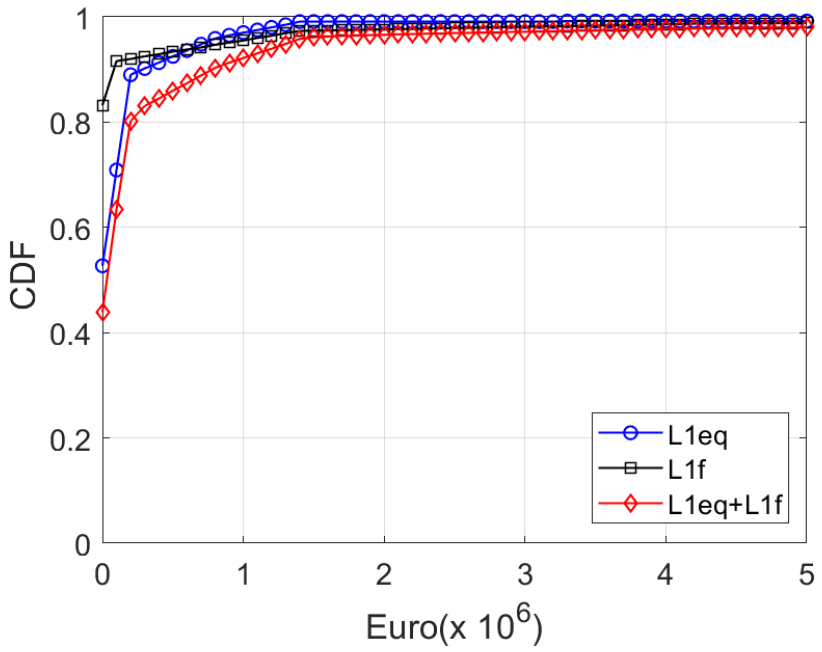


Figure 2.3.12: Obtained fire risk curve for the loft compartment with reference to Tr=50 years.

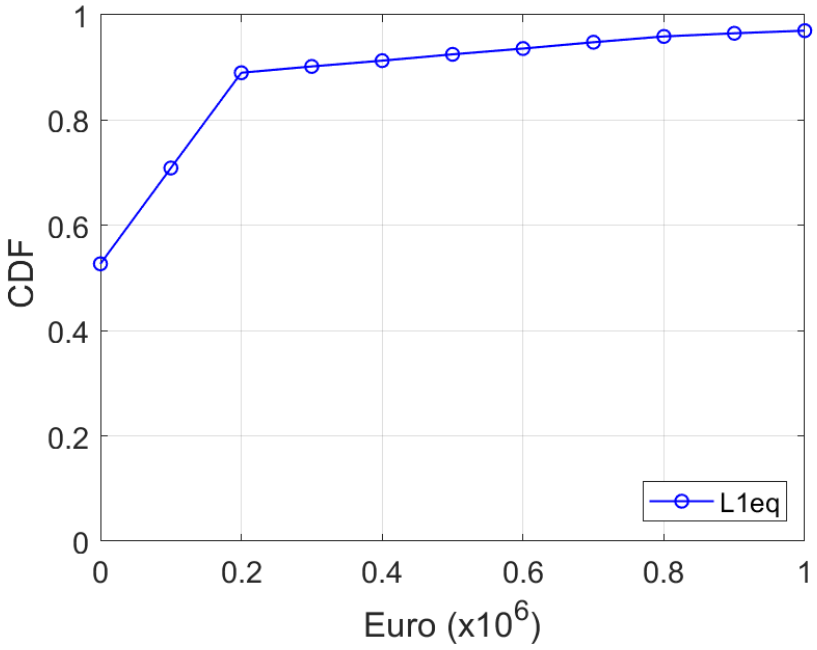
1.2 Total risk curve L1

The "total risk" curve has been obtained by combining the risk curve related to each considered hazard according to the procedure introduced in part1.

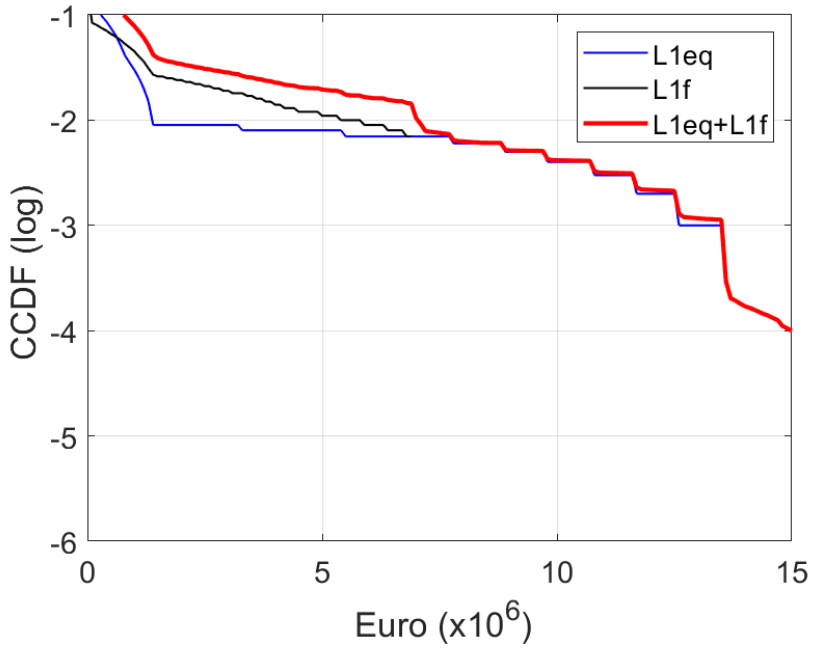
Figure 2.3.13 provides the cumulative distribution functions CDF and complementary cumulative distribution curves CCDF of risk curve L1 related to the combination of earthquake and fire hazards.



(a)



(b)



(c)

Figure 2.3.13: Loss curves L1 considering fire and earthquake hazards: (a) CDF; (b) CDF, zoom; (c) CCDF in log scale.

The total risk curve L1 (red thick curve) provides the economic losses associated to structural damages due to earthquake and fires. The following observations can be drawn:

- An economic loss of around 1 million euro has a quite large probability of occurrence (10% within an observation period of 50 years).
- An economic loss of around 15 million euro has probability of occurrence of around 10^{-4} within an observation period of 50 years.