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A CONTRIBUTION TO ASSESS THE STRUCTURAL VULNERABILITY OF TRADITIONAL TIMBER PAVEMENTS

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1 - ABSTRACT

In general, **timber pavements** are the main horizontal structural elements of the Portuguese traditional buildings. Since these types of buildings required to be preserved, the **maintenance** of timber pavements is crucial. However and unfortunately, the demolition of the interior of traditional buildings still is a current building option in rehabilitation processes. This building scenario is more expressive in private estate, in particular, in private dwellings. This option may be due to the lack of technical knowledge concerning timber pavements. Therefore, this paper intends to give a contribution in this matter by proposing an expedite methodology able to assess the **structural vulnerability** of these types of horizontal structural elements. Mapping the different structural vulnerability degrees of a traditional timber pavement may give guidance for maintenance, inspection and/or reinforcement design processes.

2 - TRADITIONAL PORTUGUESE CONSTRUCTION

Granite, schist, tabique, adobe, rammed earth and Pombalina are some traditional Portuguese construction types. In general, the interior structural elements such as the upper floor pavements, the roof structure, the interior staircases, and the partition walls tend to be essentially timber based elements.



Figure 1: Examples of two different mixed traditional Portuguese construction (Portugal, 2012)

3 - TRADITIONAL TIMBER PAVEMENTS

In general, traditional Portuguese timber pavements are beamed structural systems, Figure 2. Beams displayed equidistant to each other (I in Figure 2), directly supported in their tops on walls, and linked to each other by flooring boards (III in Figure 2) and/or rafters (II in Figure 2), is a common building solution of this type of horizontal timber structural element.

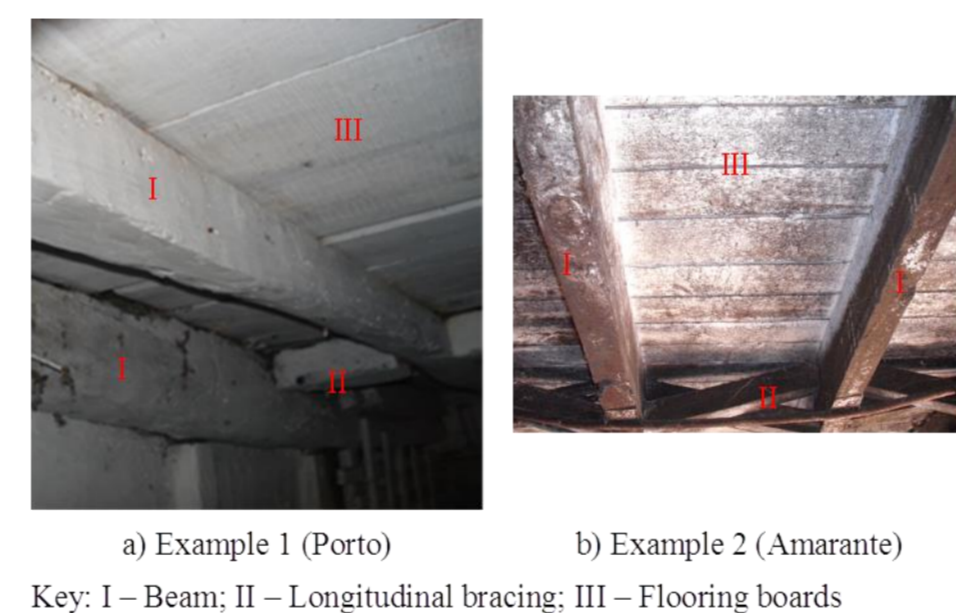


Figure 2: Common traditional timber pavements (Portugal, 2012)

4 - STRUCTURAL VULNERABILITY ASSESSEMENT OF TRADITIONAL PORTUGUESE TIMBER PAVEMENTS

In this context, the vulnerability concept is related to the case in which small damage can lead to disproportionate consequence. The separateness (γ), the relative damage demand (D_r) and the vulnerability index (ϕ) are key parameters in the structural vulnerability theory. The separateness is a measure of failure consequence. The relative damage demand is the ratio of the damage demand of the failure scenario to the maximum possible damage demand of a failure scenario in the structural system. The vulnerability index is a measure of the vulnerability of a structure. In the context of traditional timber pavements, an extended termite attack, an unexpected load, support instability or a fire are some possible causes of structural failure. It is considered that during the occurrence of a deteriorating event, the pavement is in service and, therefore, loaded with permanent and live loads. It was assumed that the load acting on the failed beam(s) is redistributed for the neighboring beams. Thus, this process may trigger a progressive failure conducting to the total collapse.

Based on these assumptions, Figures 3 and 4 show schematically the failure consequence of the failing of a single beam (Figure 3, Case I) and of the failing of two adjacent beams (Figure 4, Case II), respectively. On the other hand, the respective vulnerable parameters are displayed in Table 1. Based on these results, the failure of two adjacent beams may lead to the loss of the complete pavement ($\gamma=1$) and this timber structural system may have a vulnerability index (ϕ) equal to 11.83.

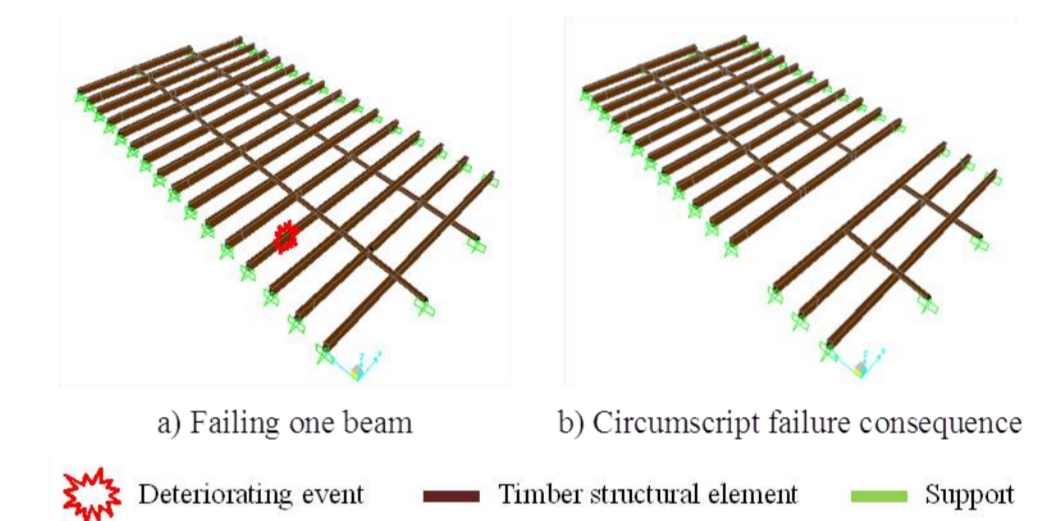


Figure 3: Case I – Failing a single beam

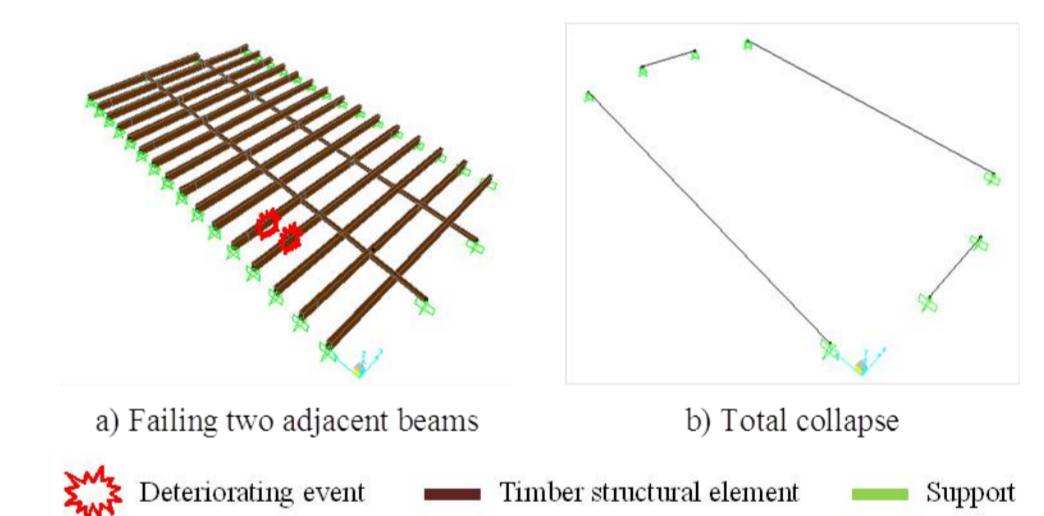


Figure 4: Case II – Failing two adjacent beams

Table 1: Structural vulnerability assessment of traditional timber pavements

Failure Scenario	γ	D_r	ϕ
Case I	0.14	0.042	3.34
Case II	1.00	0.085	11.83

5 - CONCLUSION

The main traditional buildings of the north-east part of Portugal are identified and also some typical timber pavements are presented. An expedite methodology for the structural vulnerability assessment of these types of horizontal structural elements is briefly explained and proposed. It was concluded that the failure of two adjacent beams may lead to the total loss of the timber pavement.

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