Investigation of structural timber joints used in two heritage buildings located in Gorgan: Case studies in North of Iran

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Abstract This paper aims to introduce some features of two most important old constructions of Gorgan (North of Iran), which were built approximately 150 years ago. Considerably, solid wood were utilized in large amount as structural elements like beams, columns, rafters, roofing and flooring system. However, brick and cob were used in walls. Some more important of their architectural and structural characteristics with emphasizing on wooden materials will be introduced. Existing faults and their reasons are discussed. It was found that the buildings could tolerate the past heavy earthquakes due to their special joints configurations.

Keywords Timber construction, Joints, Earthquake, Heritage.

1. INTRODUCTION

This papers aims to show some features of two most important old constructions of Gorgan (North of Iran), called *School of Taghavi and House of Bagheri*. These buildings were built with similar architectural style, approximately 150 years ago in Qajar dynasty (Madhoushi and Eimanian 2010). These buildings are now under repair. Solid wood was utilized in large amounts as a construction material in structural elements. However, other traditional materials i.e. brick and cob (a mixture of clay and straw) were used for walls. They have been exposed to natural environmental conditions for a long time. However, the buildings have interestingly withstood several past heavy earthquakes from 1900s and are now nearly in acceptable condition. The conservation and repair of these mostly timber buildings are important due to the unique response of timber structural members under seismic loading (Ceccotti et al. 2006, Tampone and Messeri 2006).

2. MATERIALS AND METHODS

A visual study was conducted of existing faults and their reasons. For this reason, numerous high quality digital pictures were captured. The adopted repair methods are explained and some comments on those methods are considered. Furthermore, the wooden species are identified in the laboratory at macroscopic and microscopic levels. Also, the resistance of buildings under the past earthquakes was considered (Tampone and Messeri 2006).

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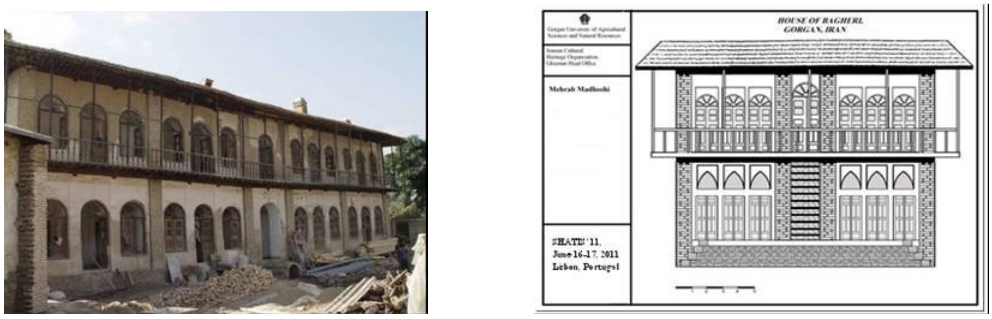
3. RESULTS

3.1. Architectural and Structural Characteristics

The *School of Taghavi* possesses eight separate rooms at each story with numerous doors and windows. It is a single two-stories building with a main step between floors "Figure 1a". The *House of Bagheri* is a collection of several main buildings ad compounds and yards. The buildings have nearly identical architectural characteristics and the plan of one building is shown in "Figure 1b"
At both buildings, the influence of Islamic art can be seen as the dome shaped window designs.



(a) (b)

Figure 1- (a) A view from School of Taghavi and (b) A plan of one building in House of Bagheri.

3.2. Faults and Repairs

The main faults can be considered in three groups as follows: 1. corrosion / by weathering, 2. decay/ by fungi attack and 3. internal holes/ by insects. These faults (or defects) are more or less common in North of Iran because of the climate. However, their distribution depends on area and species.
Corrosion caused by weathering was found in opening frames and balconies. Internal holes due to insects were also found in some parts especially where the hardwood was used. It is obvious that the insects are not living anymore in wooden members, however, their effects on mechanical properties is very considerable. Although the members affected by this fault were renewed they were not considered in some areas and were ignored during restoration.

3.3. Wood Species

The wood members can be considered as domestic wood (hradwood) and imported woods (softwood).

3.4. Earthequake Resistance

Last earthquakes during last century in Gorgan could disaster a large number of buildings; however the mentioned builidngs could tolerate the past heavy earthquakes. The main reason to this resistance might be related to their special joints configurations. Traditional joints were used in these buildings and the general forms of connections were like a damper which could absorb and dissipate the energy. Existing gap between these types of joints might play an important role, although it could be examined and approved by experimental data. These special features should be considered in restoration, although in some repair methods were ignored. Also, it can be used as a model for construction of light weight and new building especially for rural settlements.

REFERENCES

Ceccotti, A., Faccio, P., Nart, M., Samghaas, C. and Simeone, P. (2006)**.** "Seismic behaviour of historic timber frame buildings. " *In ICOMOS Intern. Wood Committee; Proc. 15th intern. Symp.*

Tampone, G., and Messeri, B. (2006). "Compliance of the practice of strengthening ancient timber structure in seismic areas with the official documents on conservation. " *In ICOMOS intern. Wood Committee, Proc. 15th intern. Symp*.

Madhoushi, M., Eimanian, J., (2010). "School of Taghavi: A historical timber structure in Iran.". *Proceedings of the 11th World Conference on Timber Engineering*.