18th International Conference
ENGINEERING MECHANICS 2012
Svratka, Czech Republic, May 14 – 17, 2012

pp. 200–201
Paper #226

INFLUENCE OF GEOMETRIC PARAMETERS ON THE STIFFNESS OF TRADITIONAL DOVETAIL TIMBER JOINT

J. Kunecký[*], R. Cacciotti[**], M. Kloiber[***]

Abstract: *The paper presents the development of numerical modeling for a traditional dovetail timber joint. The objective is to find the influence of its geometrical properties on the mechanical stiffness of the joint as well as to assess the main problems and limitations faced during the numerical modeling of the structure. An experiment with a replicated timber joint was used to validate the model. Material properties were ascertained and contact adjustment was made. Parametric study was performed: two angles of the joint beams (α, β) were varied. Suitable ranges of the angles for each type of loading were found. Main limitations and problems present in the modeling are depicted in the discussion.*

Keywords: ***Historical construction, timber joint, numerical modeling.***

1. Motivation and objectives

Historical buildings represent for contemporary professionals and researchers a seamless source of inspired engineering solutions which, if opportunely applied, provide feasible modern applications.

Although research concerning specifically wood connections is somewhat limited, considerable leaps forward are being made. In Czech Republic, for example, the *´Design and Assessment of Timber Joints of Historical Structures´* project, funded by the Ministry of Culture (started from February 2012), aims at tackling the above mentioned issues with extensive research in traditional joint testing and implementation of their mechanical behavior through experimental approach and numerical modeling, this study being one of its preliminary step.

The main objective of the analysis is to individuate and quantify the influence of the variation of parameters of a traditional dovetail timber joint and develop a suitable numerical model for a specific case. The second goal is to find the problems and limitations of the numerical modeling of timber joints.

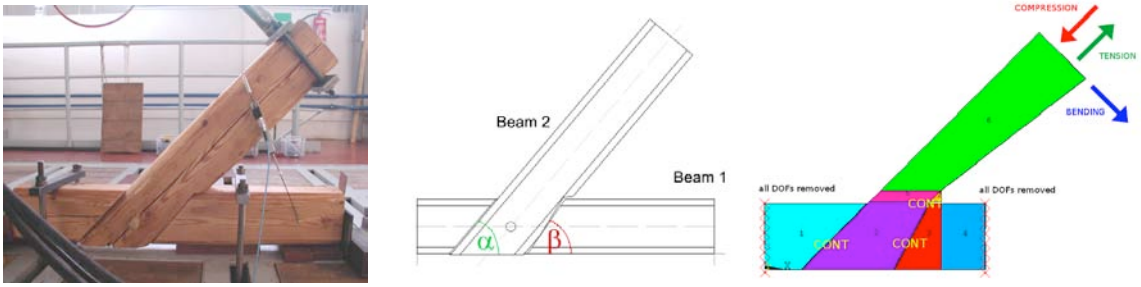

Fig. 1. The tested timber joint (left), simplified geometry with important parameters (center), FE model (right)

[*] Ing. Jiří Kunecký, PhD. : Institute of theoretical nad applied mechanics AS CR, v.v.i, Prosecká 76, 190 00, Prague, CZ, email: kunecky@itam.cas.cz

[**] Mgr. Riccardo Cacciotti : Institute of theoretical nad applied mechanics AS CR, v.v.i, Prosecká 76, 190 00, Prague, CZ, email: cacciotti@itam.cas.cz

[***] Ing. Michal Kloiber, PhD. : Institute of theoretical nad applied mechanics AS CR, v.v.i, Prosecká 76, 190 00, Prague, CZ, email: kloiber@itam.cas.cz

2. Methods

A parametric FE model is presented to clearly explore the reaction of the joint to different loading phases. Experimental techniques are thoroughly applied to appropriately adjust and validate the model. Specific experiments are performed: testing of a real historic timber joint, material testing is required in order to determine its mechanical parameters. The model is verified by comparing and cross-checking the measured and modeled values of its mechanical behavior. A sensitivity analysis, for different geometric parameters of the joint, is also performed. The work is outlined in Fig. 1.

3. Results

In the parametric study the two angles (α,β) were varied in the range of α ranging from 30° to 70° with a step of 5°. β is varied from *actual* α+2°to α+22° with a step of 5°. The reason is clear – the dovetail should always have higher β angle than α angle. The tensile and compressive loading was applied in the axis of the loaded beam 2. Bending was always perpendicular to this axis. Results from the simulations are shown in Fig. 2.

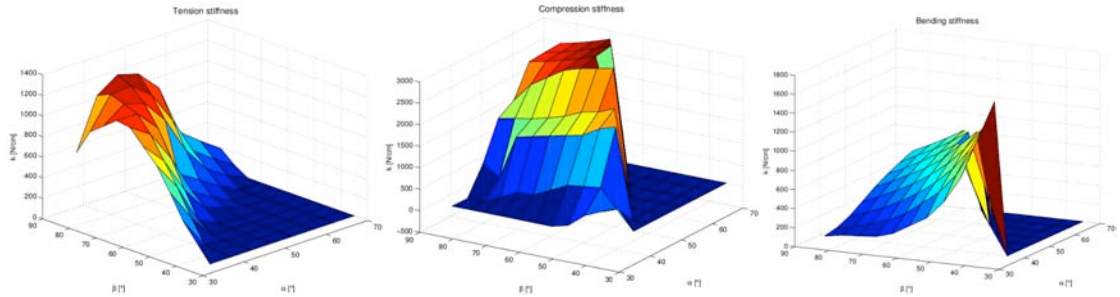

Fig. 2 Results of the analysis-beam 2 loaded using different loadings (tension, compression, bending)

4. Discussion and conclusion

This preliminary study posed one big question: how precisely it is possible to model the mechanical behavior of traditional timber joints? The answer could be that it showed many uncertainties and unknowns in the modeling and showed the way for ongoing research.

Acknowledgement

The work was supported by a kind sponsorship of grant of Ministry of Culture # DF12P01OVV004 called „*Design and Assessment of Timber Joints of Historical Structures"*. It is also gratefully acknowledged the support of grant #DF11P01OVV002.

References

Gerner, M. (2003) *Tesařské spoje*, GRADA Praha 2003, ISBN 80-247-0076-X

Požgaj, A. (1997) *Štruktúra a vlastnosti dreva,* PRÍRODA Bratislava 1997, ISBN 80-07-00960-4

Vinař, J. (2010) *Historické krovy: Typologie, průzkum, opravy*, GRADA Praha 2010, ISBN 978-80-247-3038-7