Work plan

Preface

At the moment the applicant is working at the Eindhoven University of Technology. The subject of his thesis is the dynamic (seismic) behavior of Densified Veneer Wood reinforced timber joints with expanded tube fasteners. In the first part of his master thesis he will carry out experimental research on the timber connection. The entire test program will be performed in the Pieter van Musschenbroek laboratory in Eindhoven.

Numerical analyses

At the host university the hysteresis properties of the above mentioned DVW connection with tubes are evaluated to determine properties like the energy absorption and equivalent viscous damping ratio. A special FEM sub-routine (So.ph.i) is developed by the host to transform the connection hysteresis properties into suitable elements that enable further nonlinear static and dynamic FE analyses of frame structures.

Learning objectives

(i) Use Sap 2000 to model the joint behaviour using the Pivot rule;
(ii) Learn how to use the post-processor (SO.Ph.I. software) that the host has developed to schematize the cyclic behaviour of the joint in Abaqus;
(iii) Learn how to model a frame in Abaqus for a non-linear static and nonlinear dynamic analysis;
(iv) Discuss which frame configurations require further analyses;
(v) Carrying out analyses and the methods to derive the q factors.

Competencies

(i) Modeling with Sap 2000;
(ii) Post-processing with So.Ph.i software;
(iii) Non-linear static and non-linear dynamic analysis with Abaqus;
(iv) Methods to derive q-factors.

Purpose/goals

The purpose of this STSM is to propose q-factors for moment-resisting timber frames with Densified Veneer Wood reinforced beam-column connection with expanded tube fasteners. The intention is to publish the result in ISI journals and conferences, and used to provide background reports for justification of the evaluated the q-factors for the new generation of the Eurocode 8.

Scientific Report

Week 1: Spring model and use the post-processor.

The first week was used to get to know and understand the software used for the purpose of this STSM. The first and second week were used to model the connection with Abaqus software. For simplicity the first model was a two- spring model for each tube fastener. This two- spring model gives a possibility to predict the behavior of the connections consisting of multiple tube fasteners. However this model is limited to symmetric connections meaning that the individual tube fastners all have the same fixed distance to the centre of rotation. Transformation to a generalized single spring connection representing the multiple tube fasteners is required to calculate every design stage.. Every spring had to be calibrated with post-processor software (SO.Ph.I. software). This software schematizes the cyclic behavior of the joint in Abaqus.

Week 2: Spring modeling and push over analyses

As mentioned above modelling a generalized single (rotational) spring representing the multiple tube fastener connection was an important step. In this time frame a lot of problems emerged with the force controlled behavior of the spring. Therefore it was decided to continue with modeling a portal frame and do the pushover analyses as described in Eurocode 8. The model previously developed by Daniela Wrzesniak was used for this purpose. This model was a portal frame of 3 stories and 4 bays. Attention was drawn to a build a new model to carry out a full non-linear static and a nonlinear dynamic analyses.

Week 3: Q-factor of a 1x1 portal frame (Netherlands)

It was discussed which frame configurations required further analyses. It was decided to start with a 1 story 1 bay frame. To carry out a full non-linear static and a non-linear dynamic analyses the frame had to be designed according to the Eurocode 5. To carry out a non-linear dynamic analyses, there are needed a few accelerograms that fits into the chosen construction site. The program RELAX can simulate a set of natural accelorograms from an elastic response spectrum. Using the accelorograms seven dynamic analyses were carried out to evaluate the q-factor. To check the model for a given Italian 1x1 frame a reasonable q-factor should be the result.

Week 4: Q-factor of a 1x1 portal frame (Italian)

The last week we discussed what is needed to meet the goals of the STSM. The purpose of this STSM is to propose q-factors for moment-resisting timber frames with Densified Veneer Wood reinforced beam-column connection with expanded tube fasteners. The intention is to publish the research result in an ISI journals and to present at conferences. This comes with background reports for justification of the evaluated q-factors for the new generation of the Eurocode 8. To reach these goals much effort is required. The prerequisite for accomplishing the task is being provided by the STSM grant