REGIONAAL BOUWEN AAN

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# Timber Façades Shake Table Test Design

*Product*

*of the*

**"Trust in Timber" Project**

*Human Capital, Hub Noord*

*Dr. İhsan E. Bal[1] and Dr. Eleni Smyrou[1]*

## 1. Scope and Content

Trust in Timber project primarily aims increasing trust among the "human capital" for using timber materials for structural purposes. In order to increase the impact of the bio-based materials in the overall construction industry, larger and taller structures need to be built using timber. When doing that, non-structural components, other than columns, beams and floors, should also be built using timber. Only in this way a large sum of a new building can be made of timber, thus decreasing substantially the number of carbon-producing materials, such as steel and concrete, in a large structure.

One of the components that cover a large area and constitute a considerable volume in construction is the façades (see Figure 1). Although façades are non-structural elements (i.e. they do not contribute to the load-bearing), they still need to be designed and built safe. This requires a structural engineering design, even though the elements themselves are not structural. The façades need to be stable in cases of extreme dynamic loads, such as strong winds and earthquakes. This is reason why a shake table test is designed for the timber façade panels. These tests are organized in a way to shake a timber host structure together with the attached panels, for identifying the static and dynamic properties of the façade elements but also their interaction with the host structure.

This product is a result of multi-stakeholder efforts on defining the problem, design, and production of prefabricated timber façade elements, and design of a shake table tests in order to better understand the problem in hand.

[1] *Research Group of Structural Safety and Earthquakes, Research Centre Built Environment, Hanze University of Applied Sciences, Groningen, Netherlands.*

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## 2. Method Development

This design process was performed in cooperation three companies. The first one is WEBO[2], a prefabricated timber façade producer located in the Netherlands. WEBO sponsored the design, production and delivery of the façade elements. The second company interested to participate this endeavour is Posi-Tech[3], a Dutch representative of the international company MiTek[4]. They produce timber joists and metal connectors of the joist components. Posi-Tech took over the design and production of the timber joists that will be used for making floors of the test specimen. The last company who showed interest to participate is Fischer[5], an international market leader in production of metal connectors and fasteners.

The design process followed the steps shown below:

- *Identify the question*
- *Align the stake-holder expectations*
- *Start the co-design phase*
- *Test scope definition*
- *Production of the products and delivery*

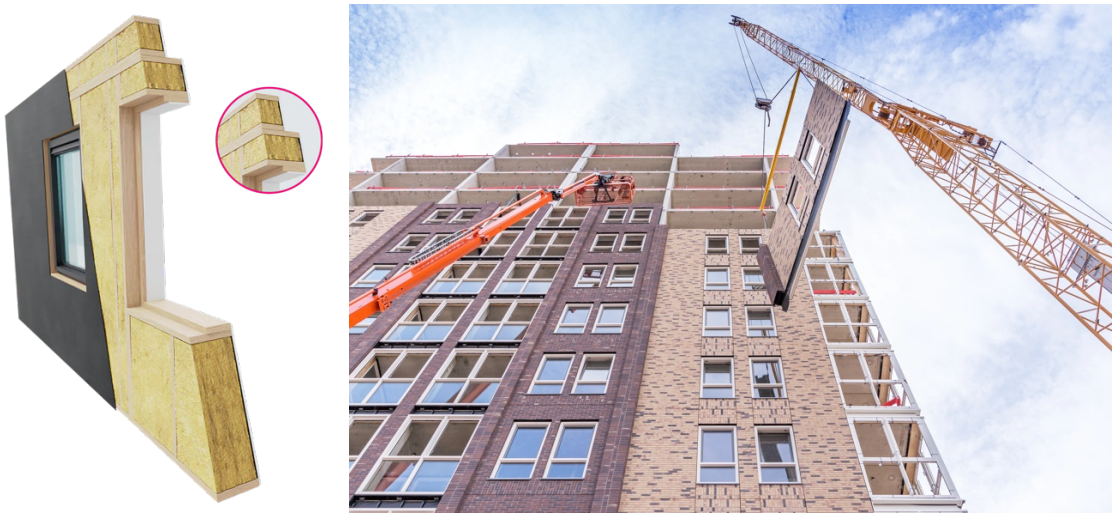

**Figure 1.** A typical prefabricated timber façade element section (left) and a real application (right, credentials: WEBO)

Lessons learned and experiences gained include:

- *Different producers use different 3D design software, which makes it difficult to exchange drawings for a co-design,*
- *A common web-based 3D design environment was set up by Hanze personnel, but it was not possible to use it because of the incompatibilities of the initial design file from producers,*

[2] https://www.webo.nl
[3] PosiiTech posi-joists, https://posi-tech.nl
[4] MiTek France, https://www.mitek.fr
[5] https://www.fischer.nl/nl-nl

- *In cases of such multi-producer co-design processes, it is extremely important to first setup the 3D co-design environment, and rules and conditions related to that,*
- *Such test settings require an engineering background, since the designed test can cause failure of the specimen.*

## 3. Test Design

For designing the host structure, similar work in the literature has been checked. Di Cesare et al (2017)[6] conducted similar tests (without façades), and their timber host structure has similar plan dimensions to the one designed here. Some of their methods have been used also here.

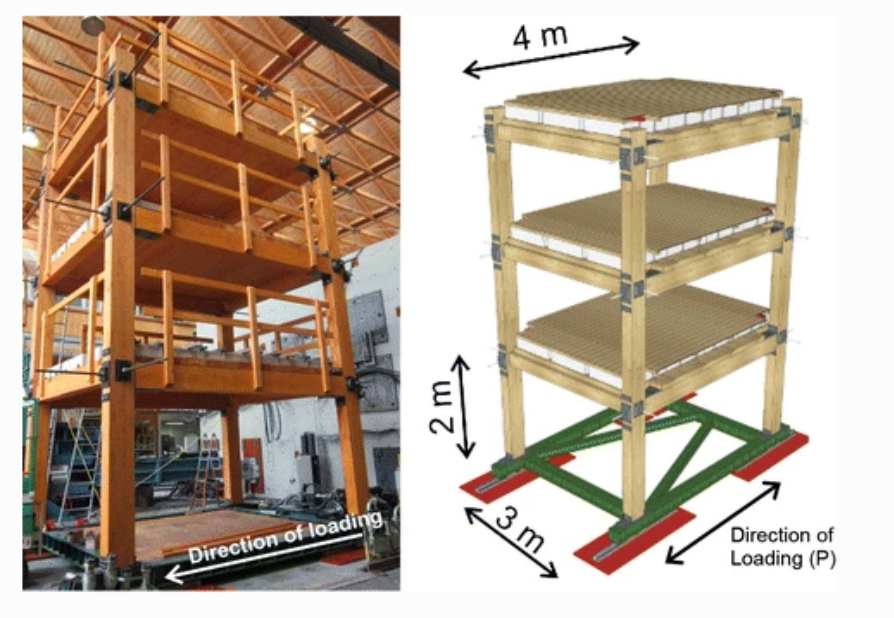


**Figure 2.** Test setup overview

The design procedure yielded a shake table test specimen, which is a 2-storey structure to be fixed on the shake table (see Figure 3 for the shake table dimensions and overall view from BuidlinG). The specimen will have a host structure (see Figure 4). The test procedure will be as follows:

- *Test the host structure's dynamic properties*

[6] *Di Cesare, A., Ponzo, F.C., Nigro, D. et al. Shaking table testing of post-tensioned timber frame building with passive energy dissipation systems. Bull Earthquake Eng* ***15****, 4475–4498 (2017).* https://doi.org/10.1007/s10518-017-0115-9

- *Test the host structure with small-to-moderate earthquake shaking*
- *Place the WEBO panels, run tests for identifying dynamic properties*
- *With the WEBO façades placed, test the total structure from low-to-high earthquake shaking*

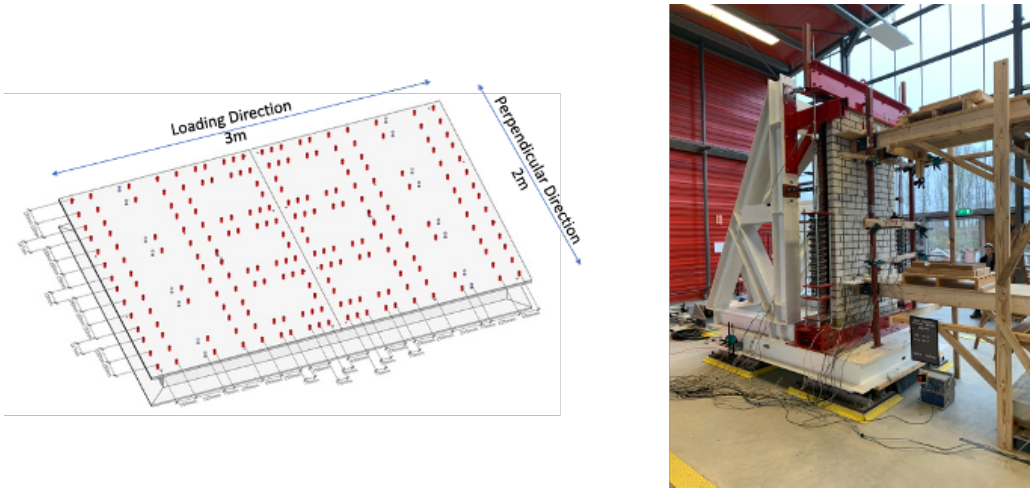


**Figure 3.** Shake table at BuildinG, dimensions (left) and picture from an actual testing on walls (right)

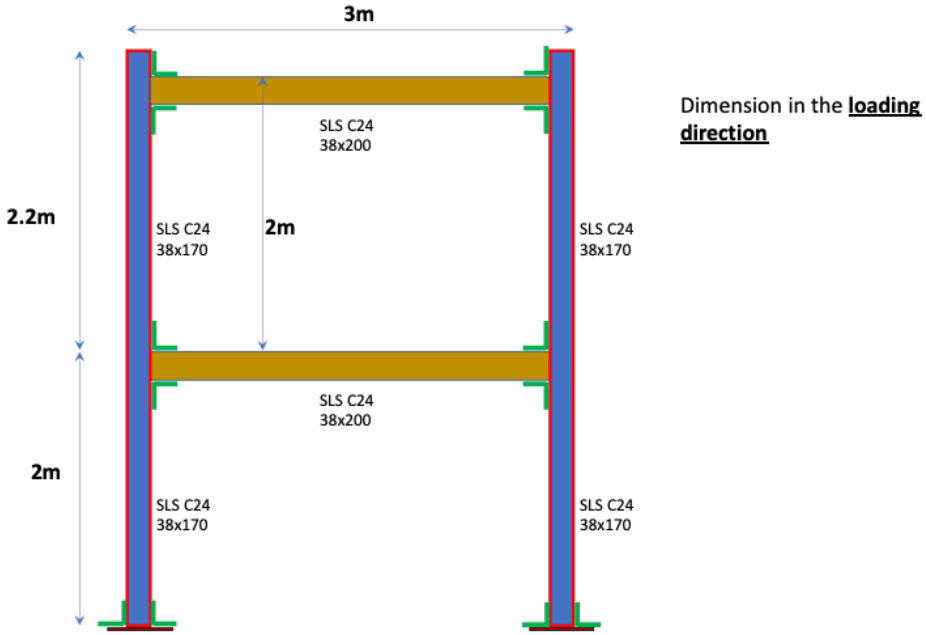


**Figure 4.** Designed timber host structure to be tested on the shake table, frame in the shaking direction

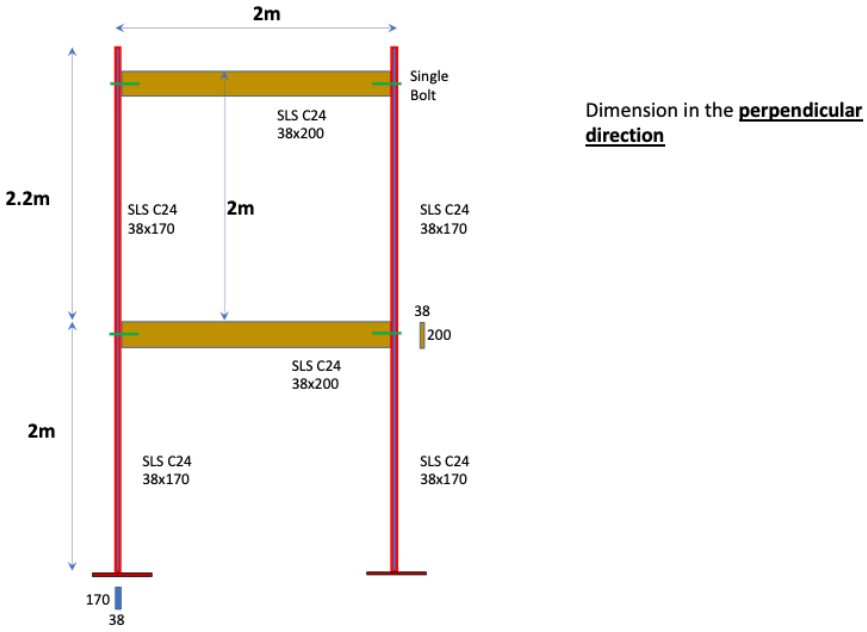


**Figure 5.** Designed timber host structure to be tested on the shake table, frame in the direction perpendicular to the shaking direction

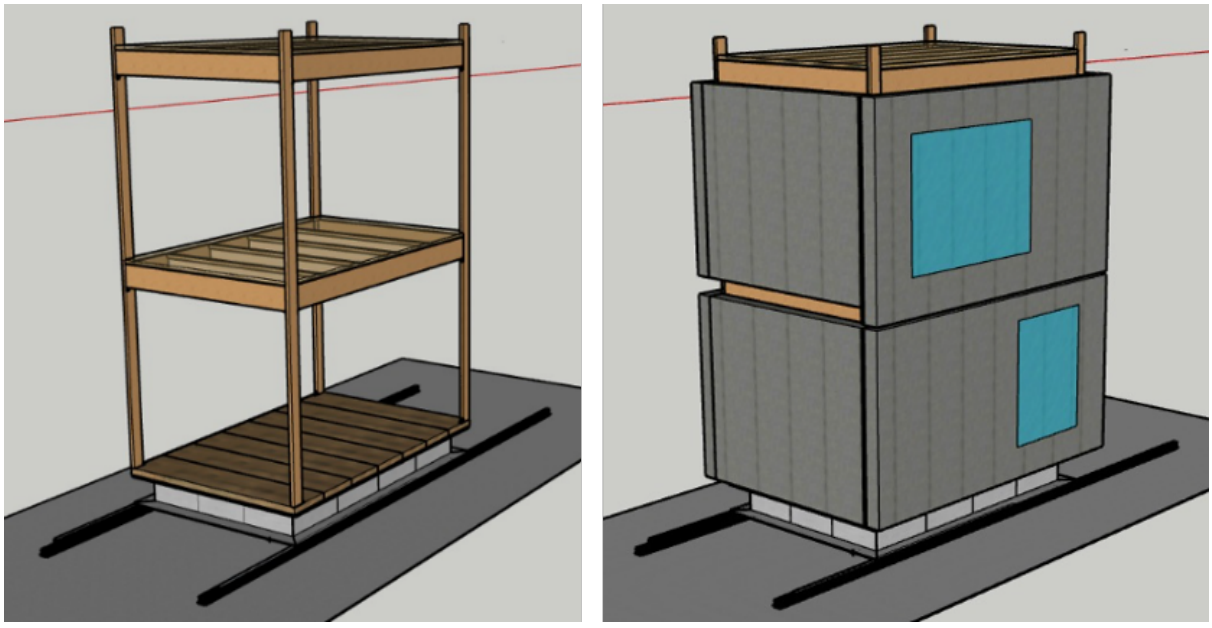

**Figure 6.** Timber host structure (left) and the structure covered with WEBO panels (right)

## 4. Concluding Remarks

The purpose of this project was stimulating cooperation among different partners in the structural timber construction business, focusing on timber prefabricated façade

elements. The best way of doing this is to identify a challenge, and via a physical testing to mobilize the interested parties around this challenge.

A test design was performed. Dimensions and connections are defined together with the stakeholders. Because of the importance of the performance of façade panels during dynamics loads, a shake table test procedure is defined.

The tests will be preformed on the shake table at BuildinG, and this product document will be updated as more results become available.