Dutu Laboratory, October 13, 2016

TFMRO

Seismic evaluation of Romanian traditional residential buildings

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Project director

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Summary

1. About TFMRO
2. Field investigation
3. Shear spring model
4. Experimental tests
5. Validate the shear spring model
6. Consider guideline for new TFM

For this purpose only the structural wall within the structure will be considered and a shear spring model will be calibrated for it, based on the deformation capacity of each component that contributes to the behavior of a TFM building wall (timber connection, compression perpendicular to grain of posts and beams, bond-slip between bricks and mortar, masonry strut, etc). The model is able to simulate the shear capacity of a TFM wall (force and top displacement) within the building, which in return, can be used to evaluate the seismic capacity of the entire building.

A field study (in Sinaia city and Vrancea seismic source area) will highlight the characteristic details (connection, layout of the timber elements, etc) of the Romanian timber frames and the different types of infills (masonry, clay, mud, etc).

Experimental tests on the materials, sub-assemblies and full scale walls of the most spread Romanian typology (from the TFM category), will validate the model and afterwards it will be extended to other similar typologies that can be found on the Romanian territory.

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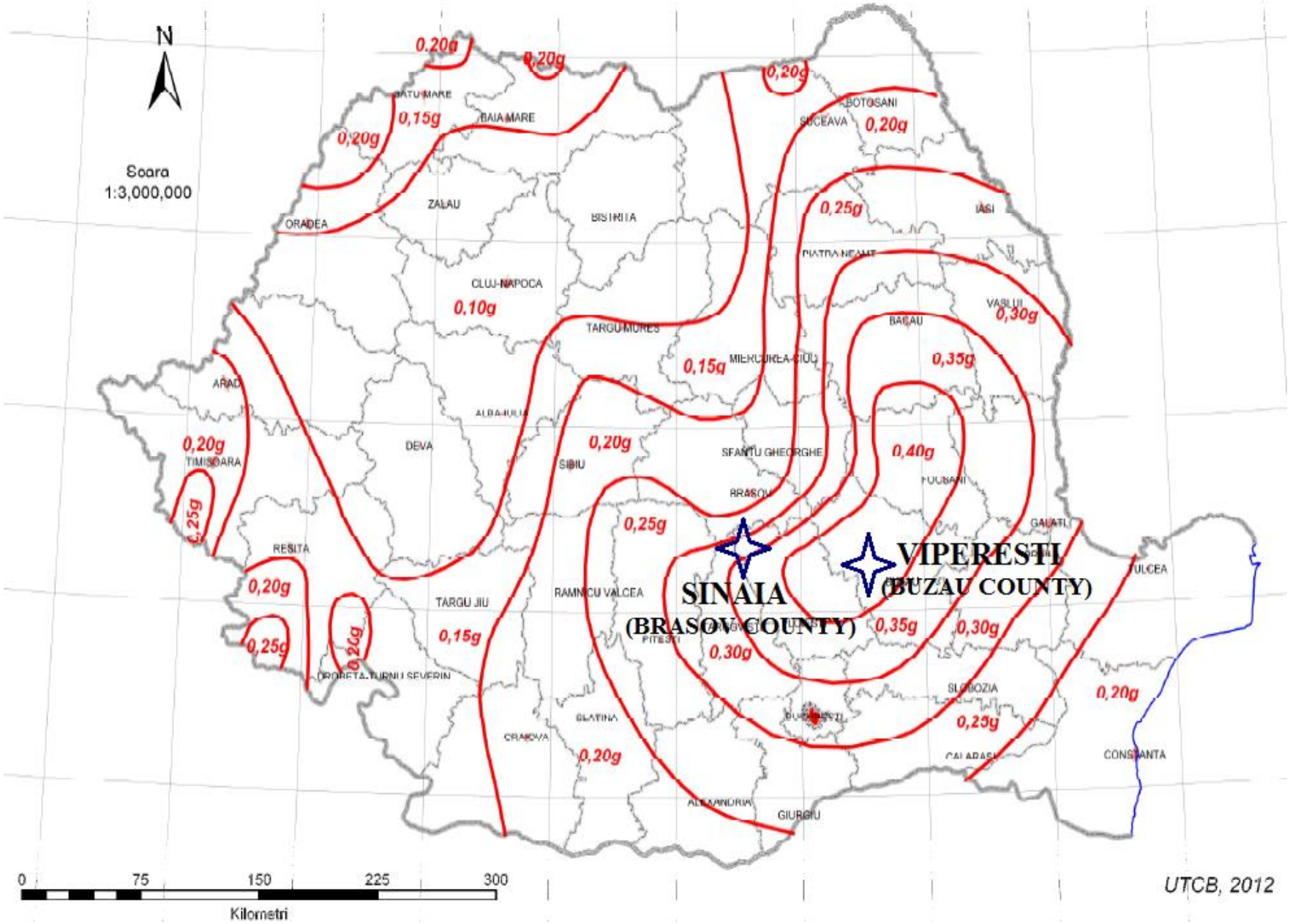

Romanian zonation of pick ground seismic accelerations a_g (according to national seismic code P100-1/2013)

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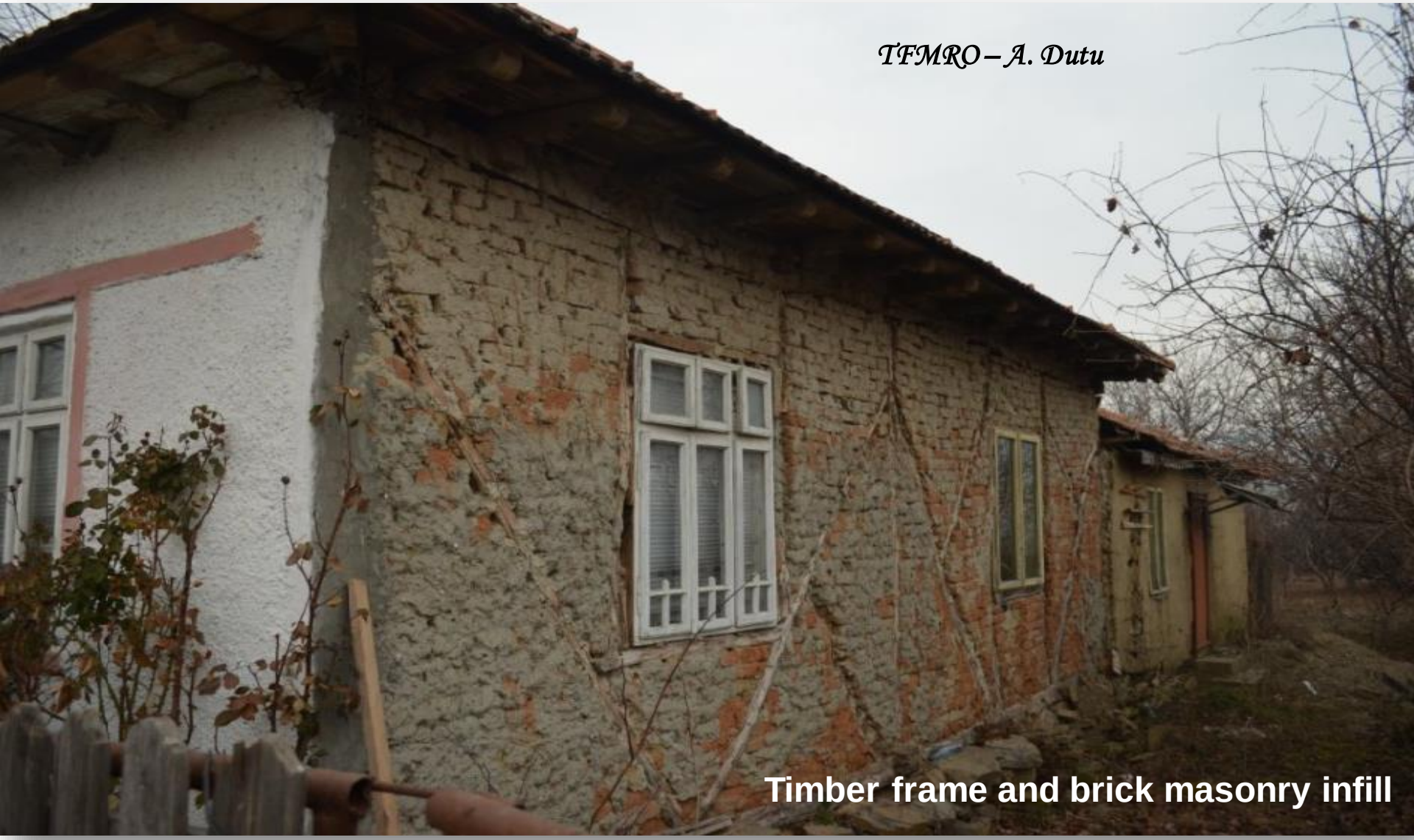
- history of the built environment and other important technical information (access to the materials, the tradition artisans, the tradition of the structural systems and the reasons they chosen the structure type, etc.);
- a photo survey was done for each house;
- it was discussed with the owners about history of the house:
  - when the house was built (period/year);
  - with who they built it (local artisans as: quarries, carpenters, masons, etc.);
  - how they have purchase the materials (wood, clay, stone, brick, etc.);
  - how they built (technological phases and materials used);
- based on which criteria they selected the structural system they built (tradition, easy to build, economic and ecologic, seismic resistant, etc.);
- the damages after earthquakes or other natural / anthropic causes they observed;
- other particular information.

Google maps

Timber framed masonry (TFM) buildings – field investigation Viperesti UTCB

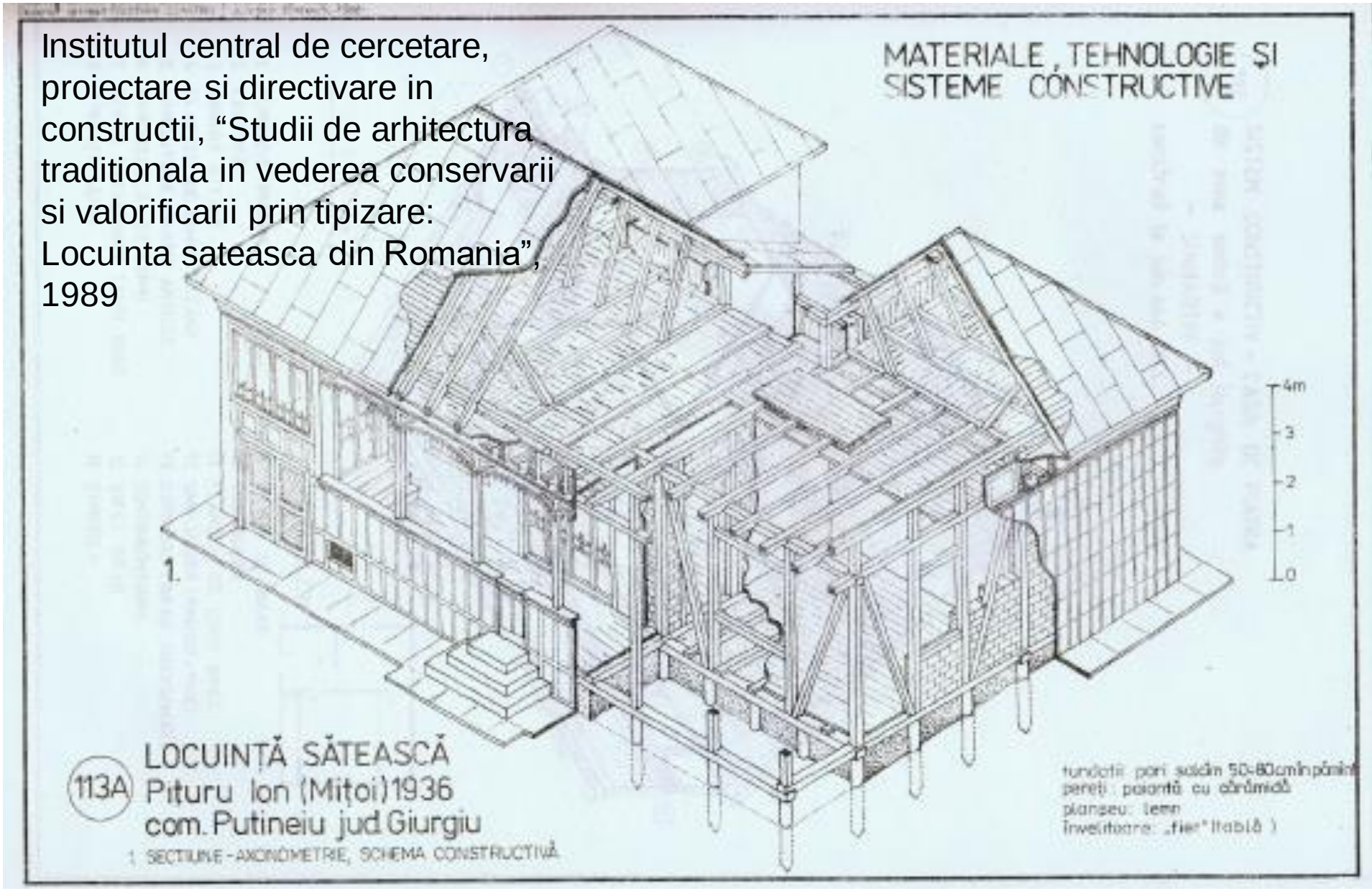


Timber frame and brick masonry infill


stone
foundations


superior stringer (wood belt/girdle)
brick masonry
infill
bracings
wood
columns
inferior stringer
stone foundations

Institutul central de cercetare, proiectare si directivare in constructii, “Studii de arhitectura traditionala in vederea conservarii si valorificarii prin tipizare: Locuinta sateasca din Romania”, 1989



Timber framed masonry (TFM) buildings – field investigation Viperesti UTCB

Timber frame and earth (clay) infill

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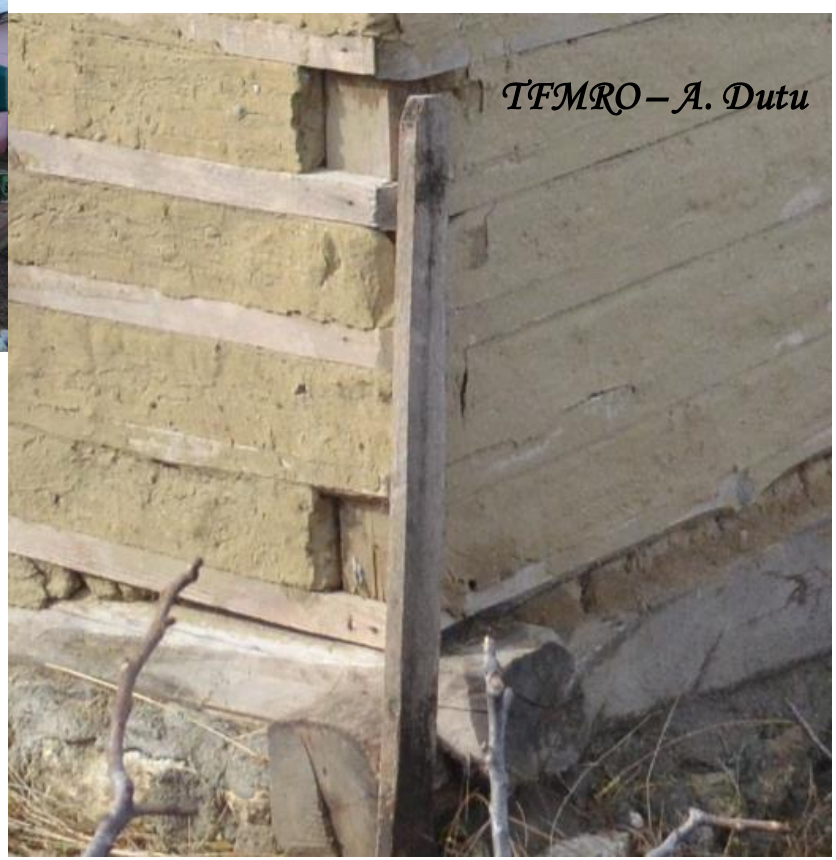
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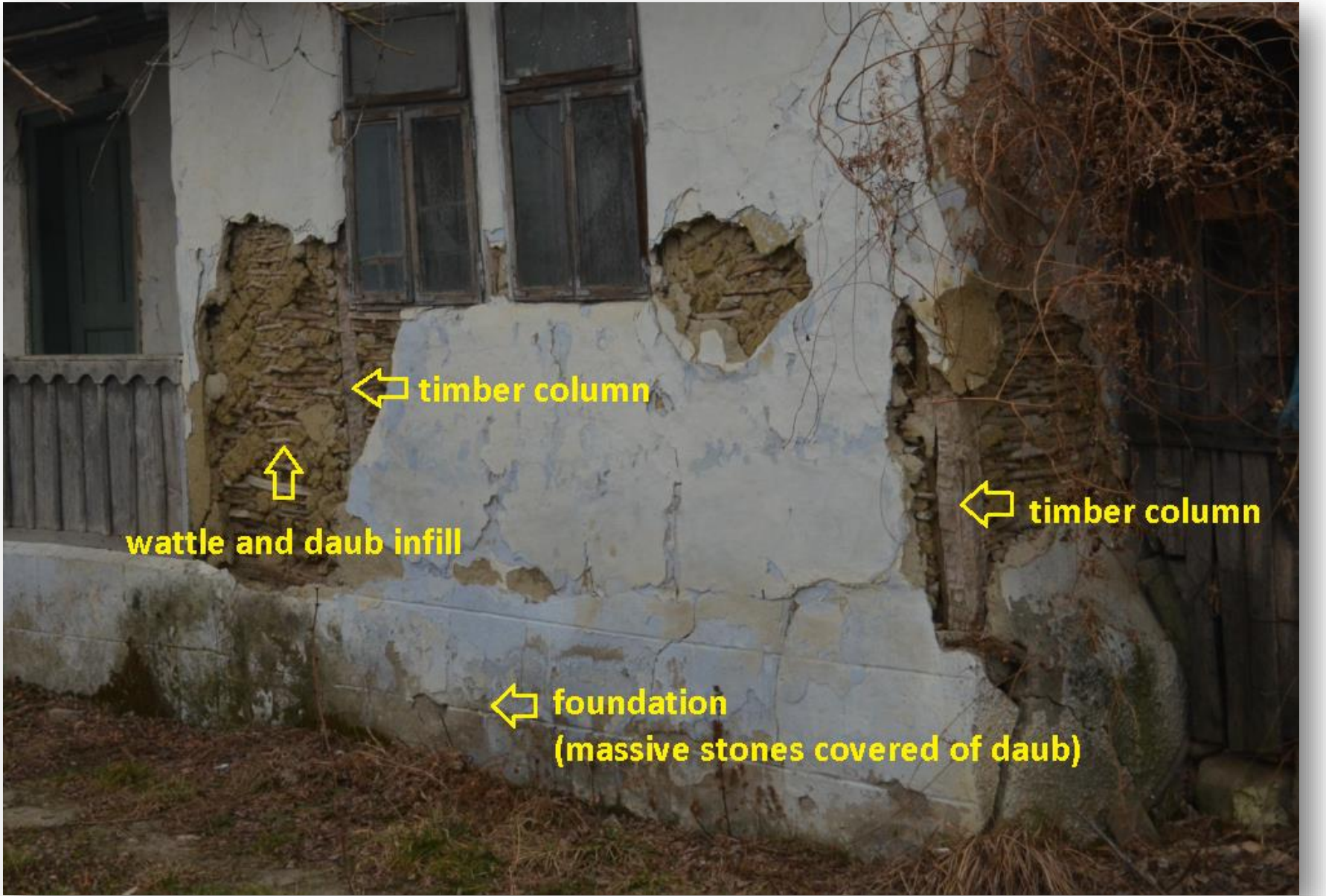
Timber framed masonry (TFM) buildings – field investigation Viperesti UTCB

Timber frame and wattle & daub infill

Timber framed masonry (TFM) buildings – field investigation Viperesti UTCB



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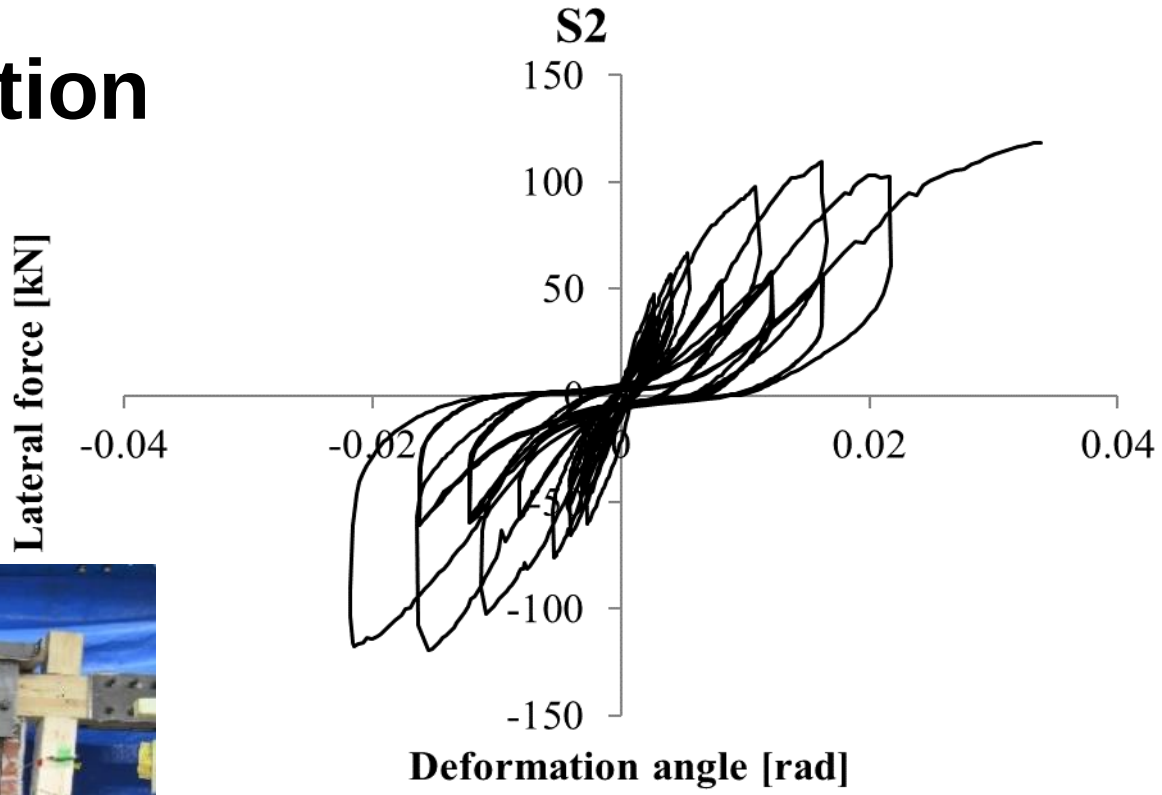
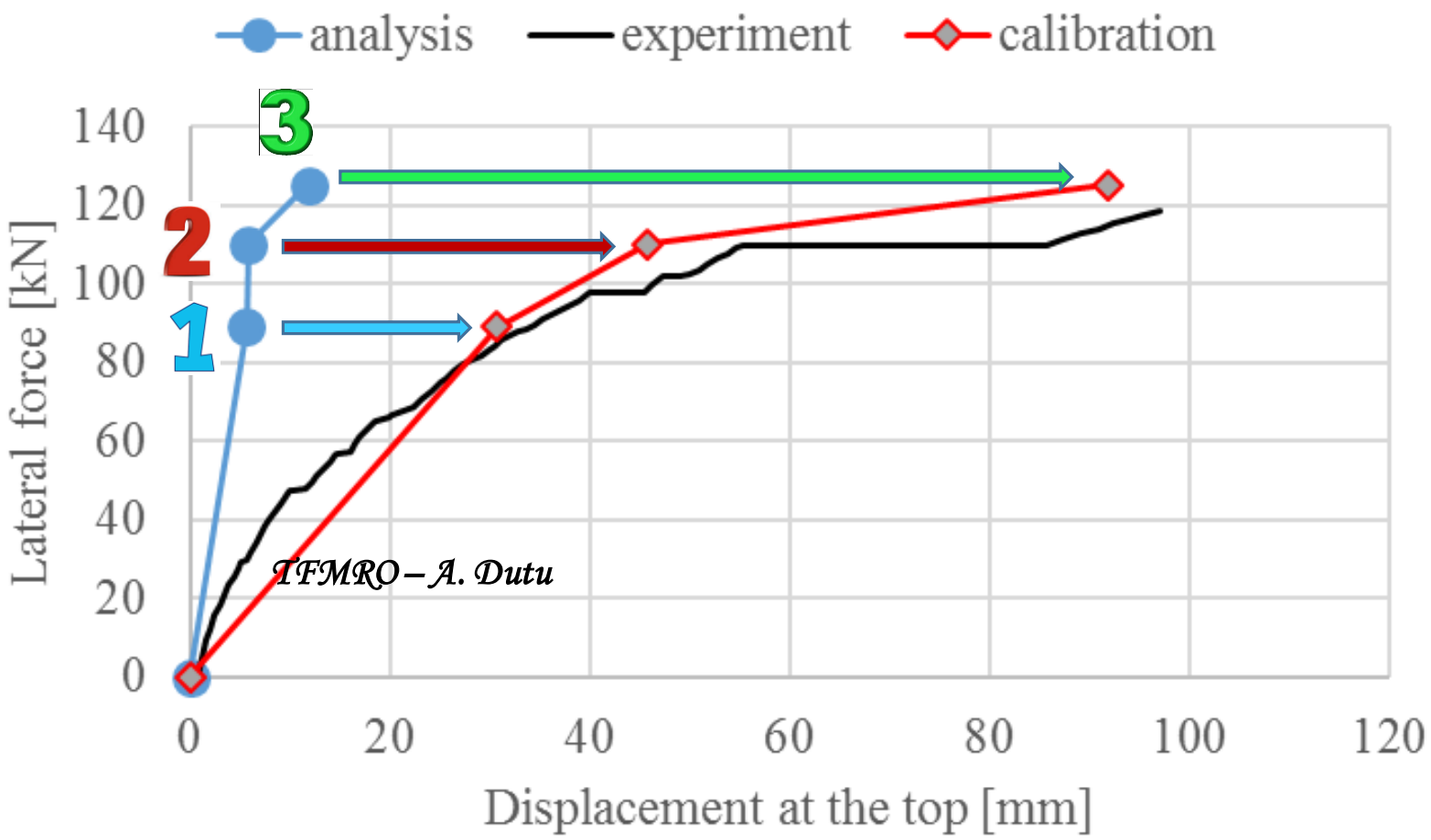
Target - evaluation



[1] Dutu, A., Sakata, H., Yamazaki, Y., and Shindo, T. (2015). “In-Plane Behavior of Timber Frames with Masonry Infills under Static Cyclic Loading.” J. Struct. Eng., 10.1061/(ASCE)ST.1943-541X.0001405, 04015140


analysis
experiment
calibration
3
2
1
140
120
100
80
60
40
20
0
Lateral force [kN]
0
20
40
60
80
100
120
Displacement at the top [mm]
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TFMRO – A. Dutu

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TFMRO – A. Dutu


TFMRO – A. Dutu
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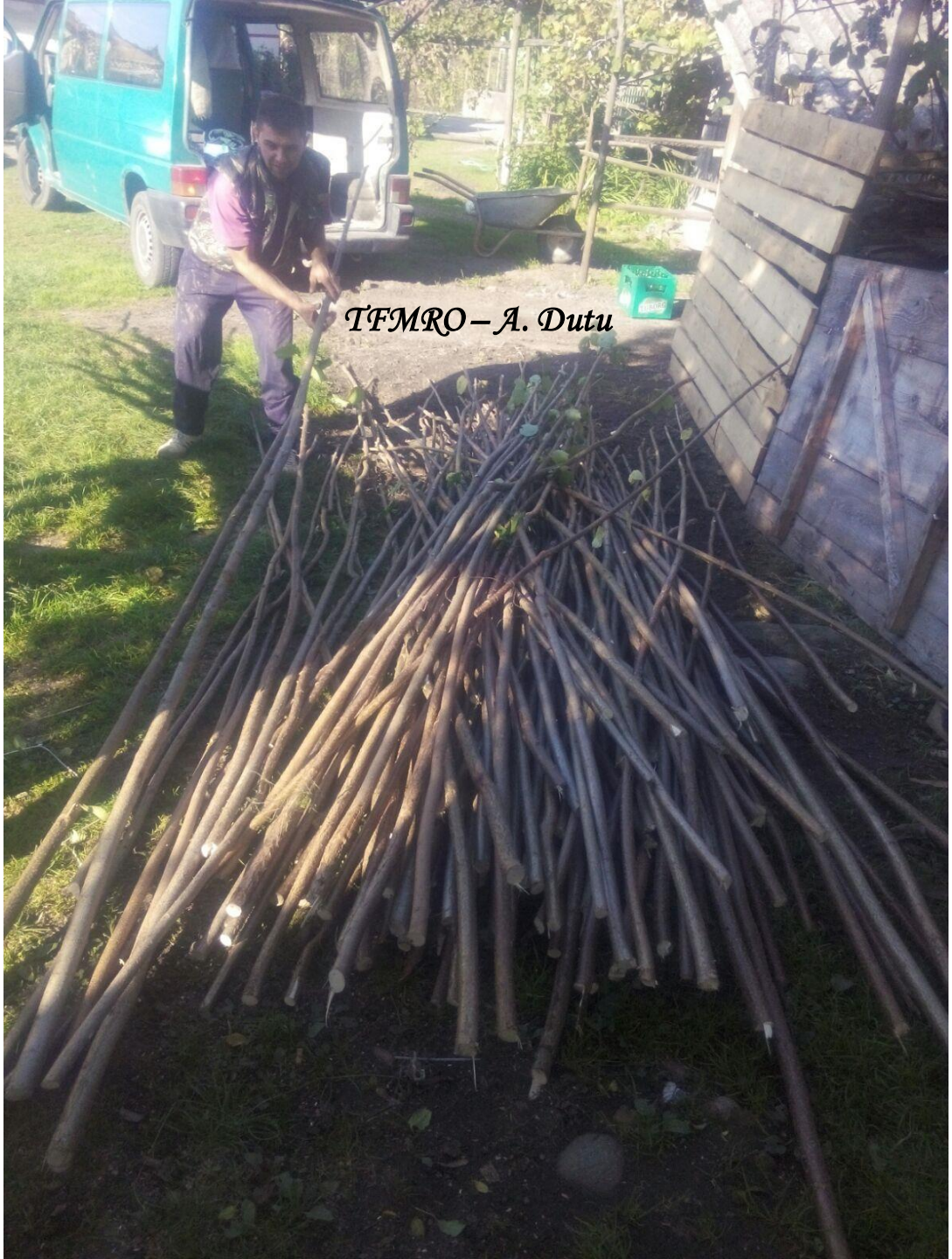
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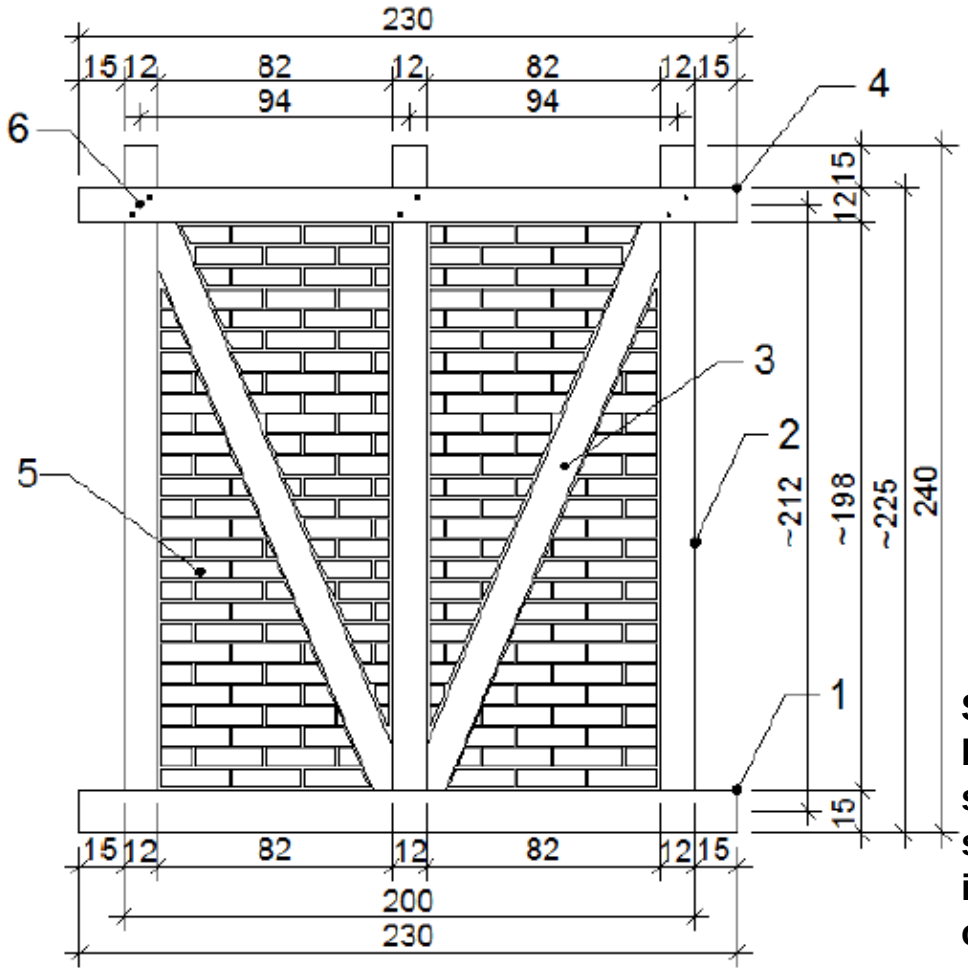
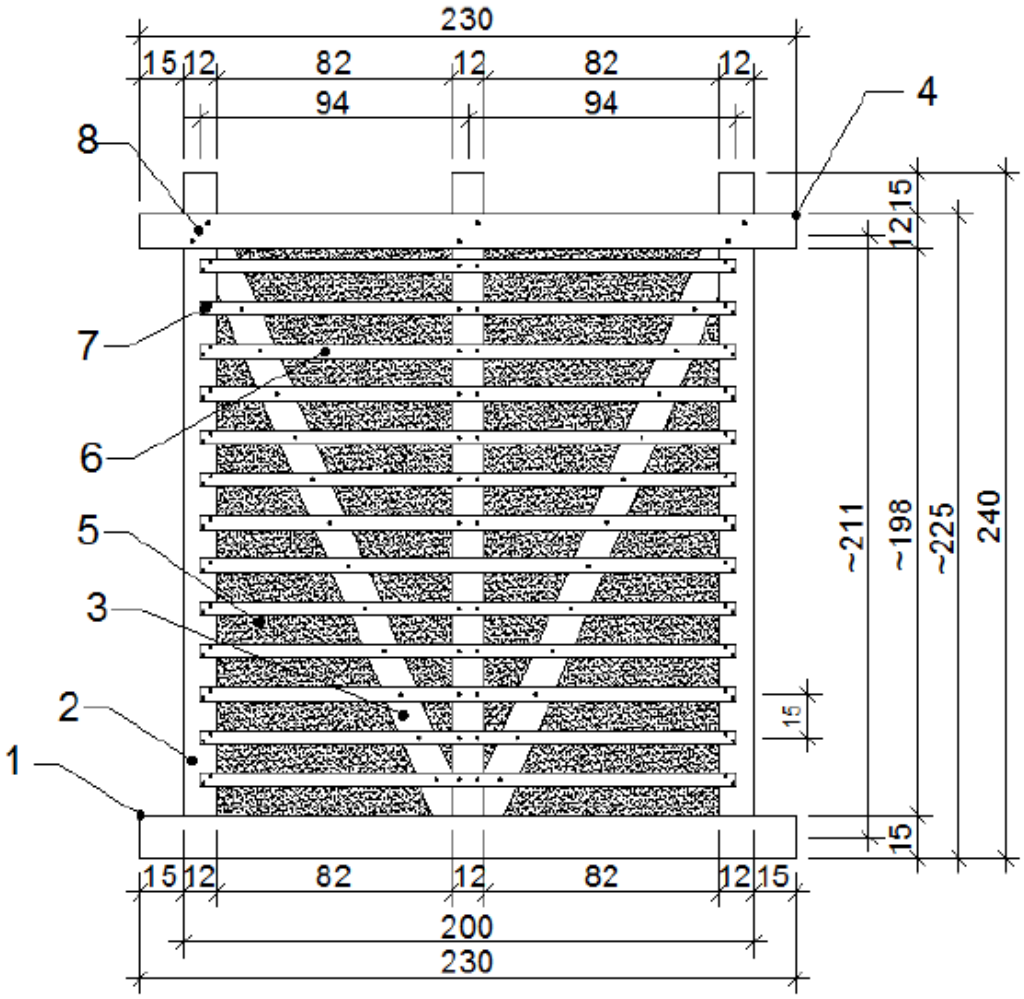
Timber frame and brick infill (Type 1);



Specimen S1 (from type 1) - timber and brick masonry infill structure: 1 – inferior stringer; 2- column; 3 – bracing; 4 – superior stringer; 5 – masonry infill; 6 – iron nails and cross – halving connections of timber elements (columns and strings)

Timber frame and earth infill (Type 2);



Specimen S2 (from type 2) - timber and earth with straw infill structure: 1 – inferior stringer; 2- column; 3 – bracing; 4 – superior stringer; 5 – earth and straw infill; 6 – timber strips; 7 – iron nails connections of strips; 8 –iron nails and cross – halving connections of timber elements (columns and strings)

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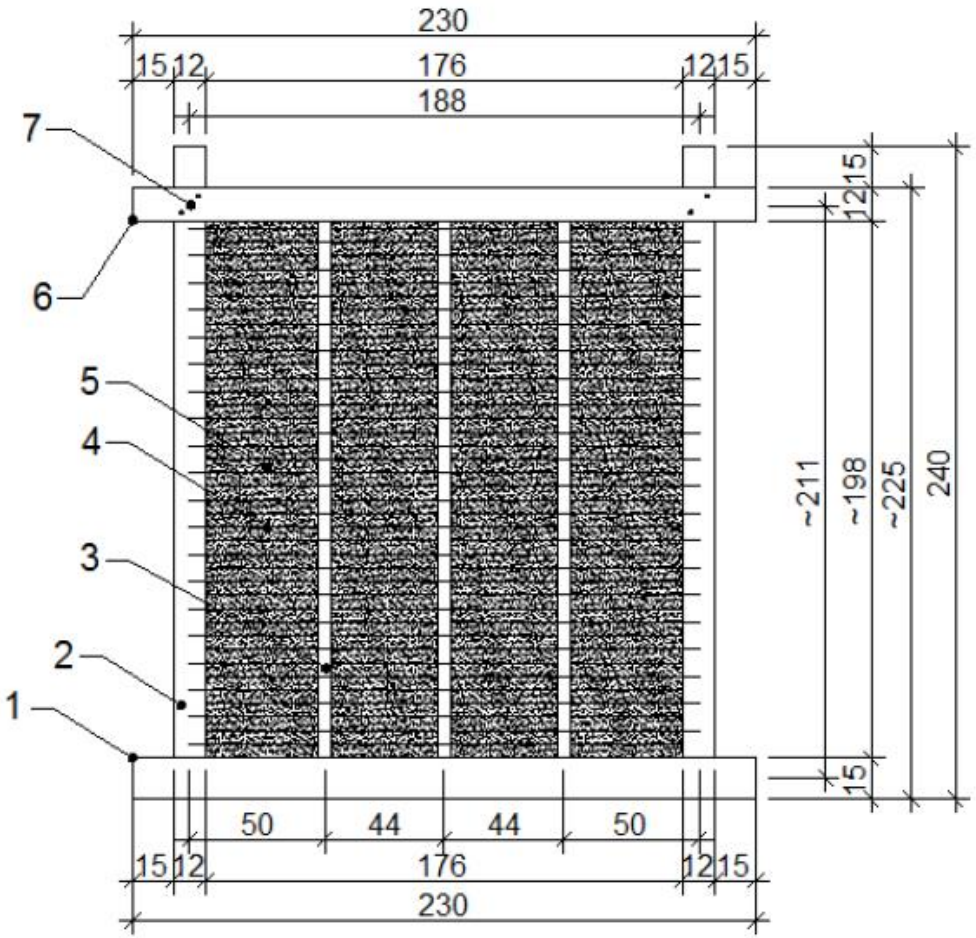
Timber frame and wattle&daub infill (Type 3);



Specimen S3 (from type 3) - timber and wattle&daub infill structure: 1 – inferior stringer; 2- column; 3 – intermediate columns; 4 – wattles; 5 – daub (earth and straw infill role); 6 – superior stringer; 7 – iron nails and cross – halving connections of timber elements (columns and strings)

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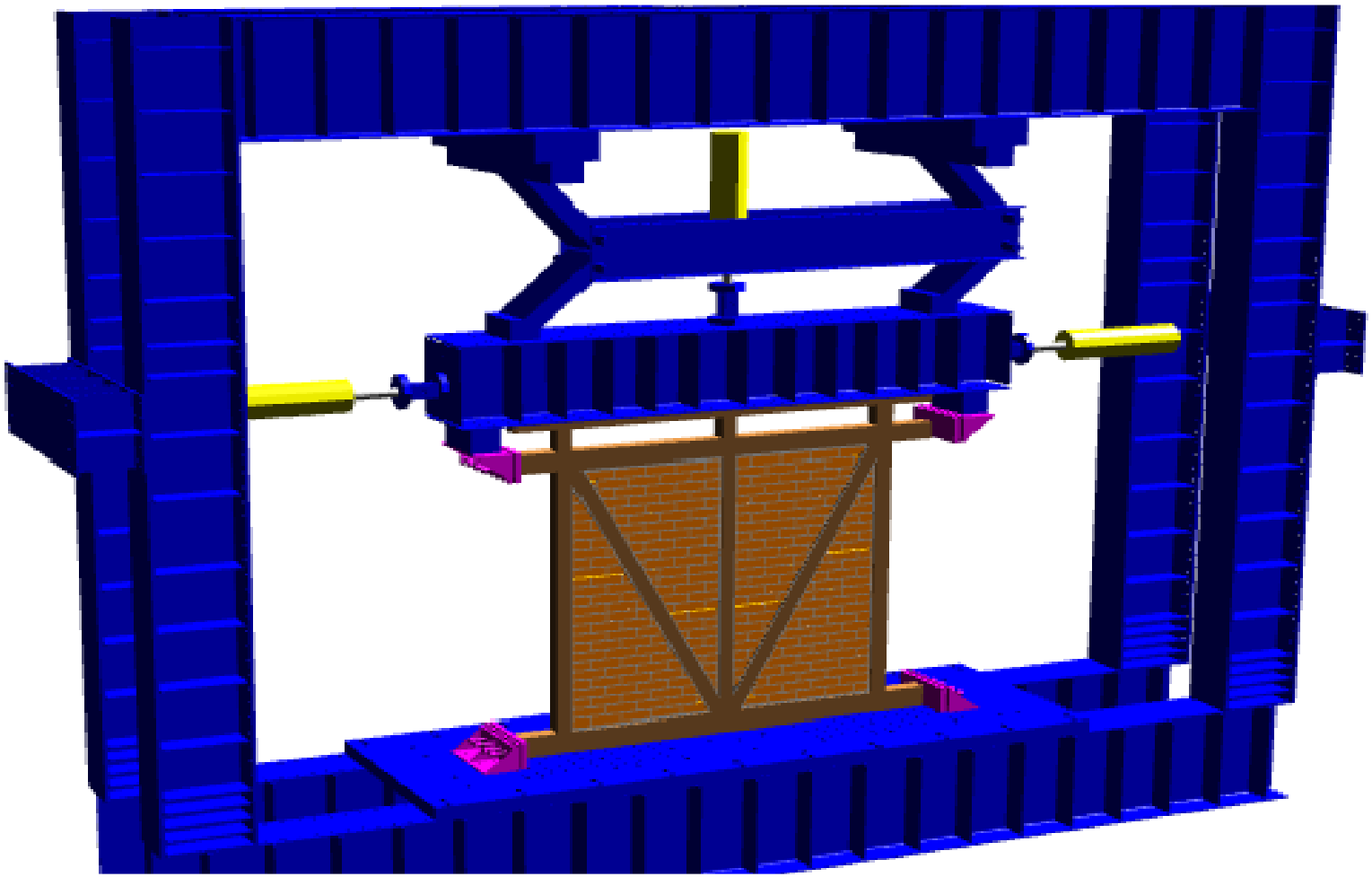
Test setup



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Strange things…

Future steps…

- **Testing**
- **Seeing weaknesses**
- **Find modern solutions to improve the traditional houses but keeping the tradition and eco-friendliness of the system**
- **Work with architect, designer and construction company to make a cheap, beautiful, eco-friendly and resilient improved traditional house**

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Thank you!