Experimental Research of XLam Wooden System Specimen KLH2-Preliminary Results

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SUMMARY:
In the frame of the bilateral Slovenian-Macedonian scientific project, experimental and analytical investigation of two massive wooden wall panel systems subjected to dynamic excitations was performed. In this paper, the results from the preformed tests for the second specimen KLH 2 consisting of two unit wall elements made of cross laminated timber with length of 122cm, are presented and discussed. The results are summarized in terms of relative displacements and absolute accelerations measured at the top of the tested specimen for various earthquake records as well as recorded slips between the two screwed panels. More detailed analysis of the results will be subject of some future paper.

Keywords: Xlam wooden structures, shaking table test, full-scale model

1. INTRODUCTION

In the past few years there has been a significant growth of cross laminated timber buildings throughout Europe and lately, Canada and North America. Cross laminated timber consists of cross-staked stripes of wood glued together to form solid panels. It is a modern composite material with more uniform and better mechanical properties than the wood itself, with excellent ecological features, simple and fast erection and human friendly for the living environment.

Simultaneously with the increase of the popularity of this innovative building system, there has increased the number of research projects aimed at obtaining comprehensive information on the behavior of this type of structures from various aspects. Since the majority of cross laminated structures were constructed in Germany, Austria and Switzerland, i.e., countries characterized by a low seismic risk, recent investigations have been focused on their seismic safety in order to make them competitive in seismic prone countries, as well.

In the IZIIS Dynamic Testing Laboratory, shaking table tests were conducted on two single storey cross laminated models in order to get an insight into the seismic behavior of the XLam structures and determine the main characteristics of their dynamic response. Description of the shaking table tests and some of the test results for the first tested specimen KLH 1 can be found in Dujic et al. (2006) and Stojmanovska et al. (2010). This paper provides a brief presentation of the results obtained from the tests on the second specimen performed for selected earthquake records.

Although the tested models and the testing procedure are already presented herein, for the sake of clarity, only a brief explanation of specimen KLH 2 is given.

1.1. Brief description of the construction system and procedure

The second tested specimen KLH 2 was constructed from two wall elements assembled by screwing together two basic units proportioned 122/272/9.4 cm and a roof element, 244/210/16.6 cm, (Figure

1). The elements are product of the KLH Austrian Company Massiveholz GmbH.

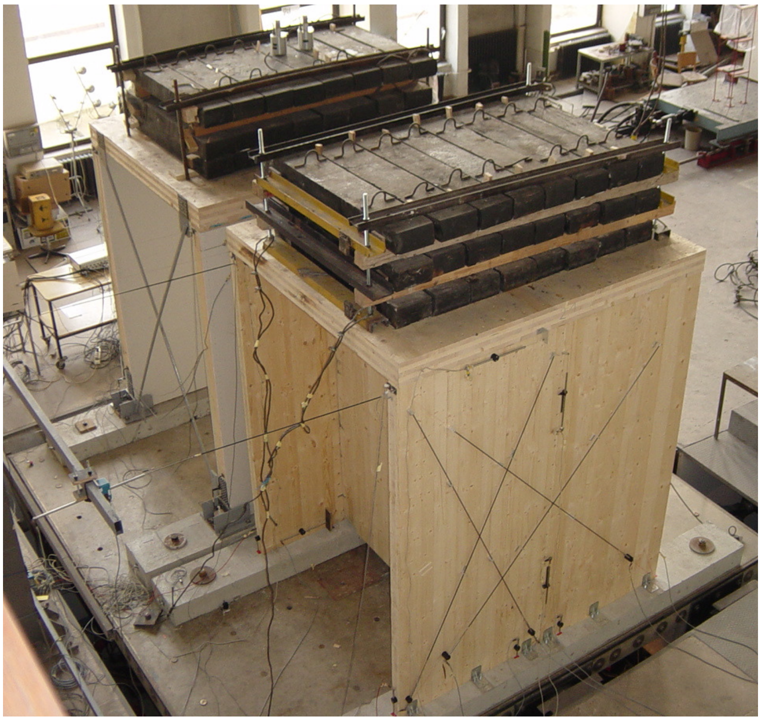

Figure 1. Specimen KLH 2

Connection to the base was made by six BMF angles and two bolts M12. Annular nails 4x60 mm were used to fasten the steel connector to the plate. The foregoing estimations resulted in an additional mass of 9.6t applied on the model, i.e., 24 steel ingots, 400 kg each, were placed and connected rigidly to the roof panel.

Figure 2 displays the disposition of the testing instrumentation for Specimen KLH 2, while Table 1 shows only the instruments and the measurements discussed in this paper. Two acquisition systems were applied (by both research teams). Linear variable differential transformers, linear potentiometers, and accelerometers were used during the tests.

Table 1. Instrumentation for Specimen KLH2

Channel	Instrument type	Description of measurement
1	LVDT	System displacements (horizontal)
7	LP	Top left abs. horizontal displacement
8	LP	Top right abs. horizontal displacement
Channel	Instrument type	Description of measurement
13	LVDT	Horizontal slip between shaking-table and foundations (right)
16	LVDT	Horizontal slip between shaking-table and foundations (left)
31	LVDT	Slip between two screwed single panel units (upper part, left)
32	LVDT	Slip between two screwed single panel units (lower part, left)
22	AM	Top horizontal absolute acceleration (left)
23	AM	Top horizontal absolute acceleration (right)

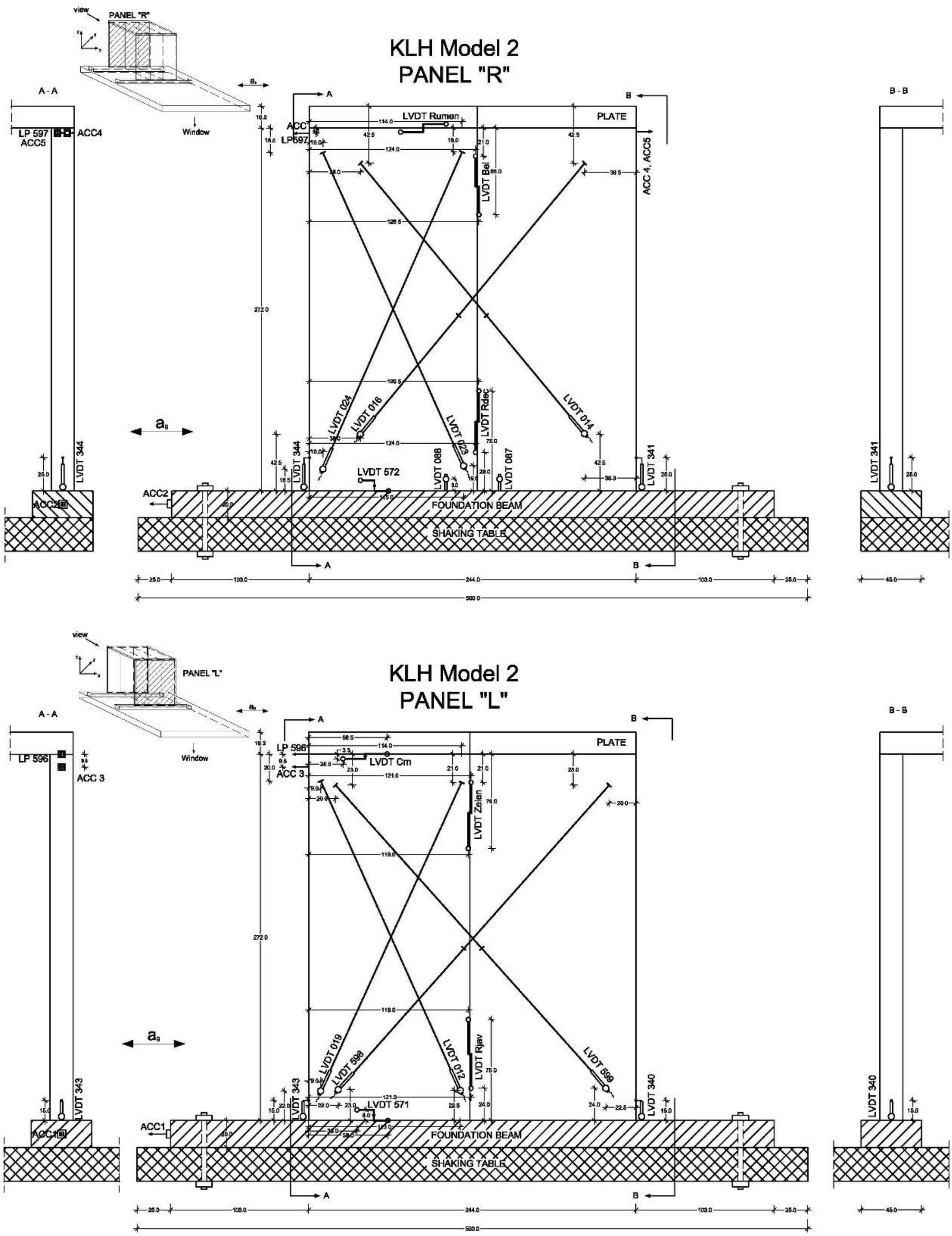

Figure 2: Disposition of testing instrumentation for Specimen 2

The testing procedure included performance of ambient and forced vibration tests to define the fundamental period of the model, harmonic excitation with frequencies of 7.5Hz and 5.0Hz and five different earthquakes with peak ground acceleration increasing gradually from 0.06g to 0.38g.

2. TESTS' OUTCOMES AND DISCUSSION

Table 2 displays the complete testing protocol for Specimen KLH 2.

Table 2. Test protocol for specimen KLH 2

Record	Span*	$a_{g,max}$ [m/sec^2]
Albstadt (y-component)	65	1.87
Albstadt (y-component)	13	
Albstadt (y-component)	26	0.78
Albstadt (x-component)	39	1.125
Tolmezzo (x-component)	233	1.93
Tolmezzo (x-component)	300	2.56
El Centro(x-component)	850	2.61
Kobe (EW component)	100	0.46
Kobe (EW component)	400	1.39
Kobe (EW component)	700	2.34
Kobe (EW component)	800	
Petrovac (x-component)	550	3.43
Harmonic Test 7.5Hz	10-40, step 10; 45	
Harmonic Test 5Hz	15; 30-60, step10	
Albstadt (y-component)	50	
Albstadt (x+y component)	13h+50v	
Tolmezzo (y-component)	400	
Tolmezzo (x-component)	400	
Tolmezzo (x+y component)	400h+500v	
Petrovac (x-component)	600	

*Span is the 1/1000 of the ultimate capacity of the shaking table during a particular test run. A span value of 100 means running of the table at 10% of its ultimate capacity.

Figure 3 and Figure 4 show the absolute accelerations and relative displacements at the top edge of the walls of Specimen KLH 2 for selected input motions, accordingly.

Maximal acceleration response was obtained for the Petrovac 550 earthquake excitation $a_{max=}$ 0.5g. Maximal relative displacement was also calculated for the Petrovac 550 earthquake record 10.27 mm.

Table 3 and Figure 5 show the recorded values for the slip between the vertically screwed units.

Table 3. Slip between the screwed panels

Record	Span	Specimen KLH 2 Slip between the screwed panels-upper part [mm]	Specimen KLH 2 Slip between thescrewed panels-lower part [mm]
Albstadt	65	0.35	0.56
El Centro	850	0.36	0.26
Kobe	700	0.24	0.38
Petrovac	550	0.63	0.83
Tolmezzo	300	0.28	0.47

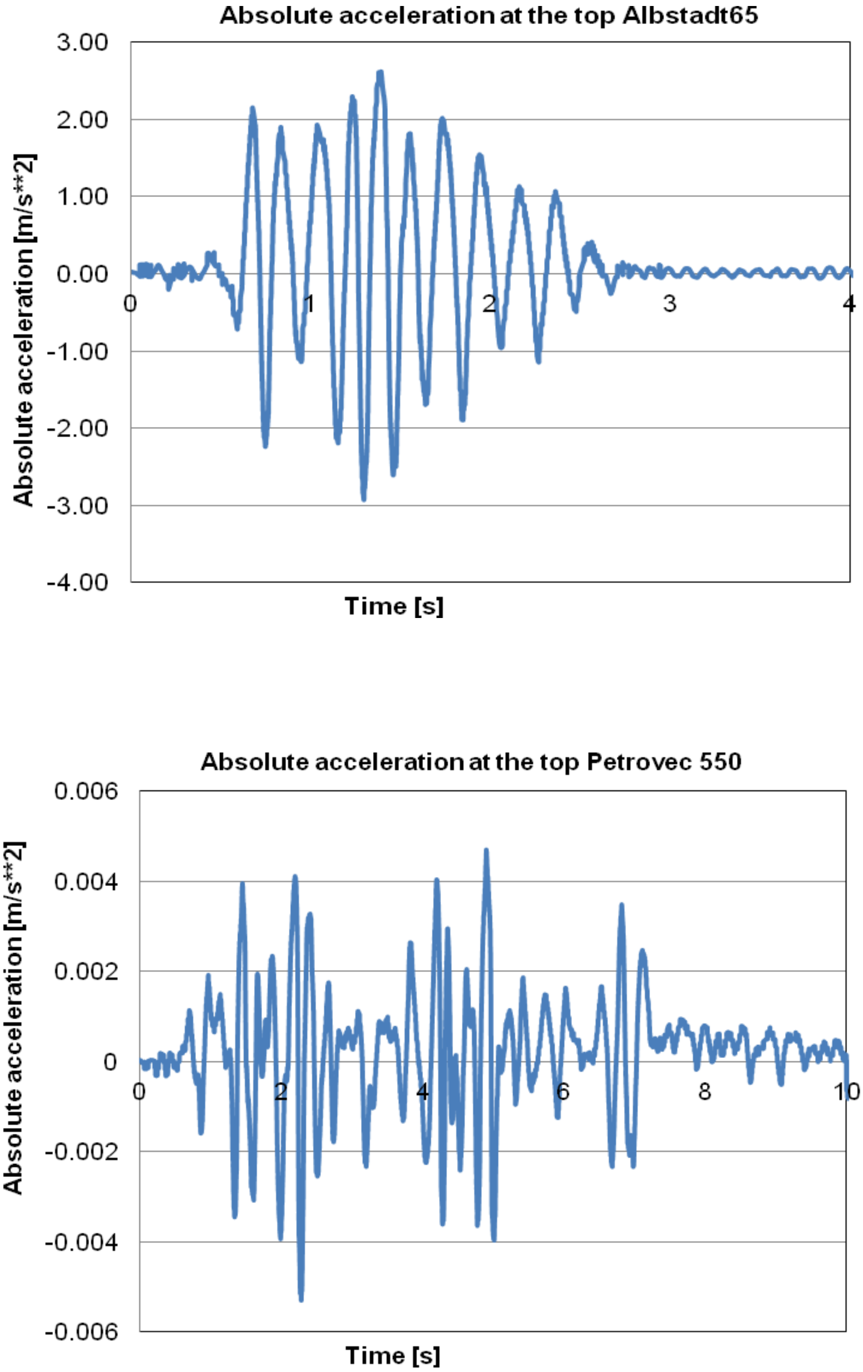

Figure 3: Recorded acceleration responses at the top of the panel for selected EQ records

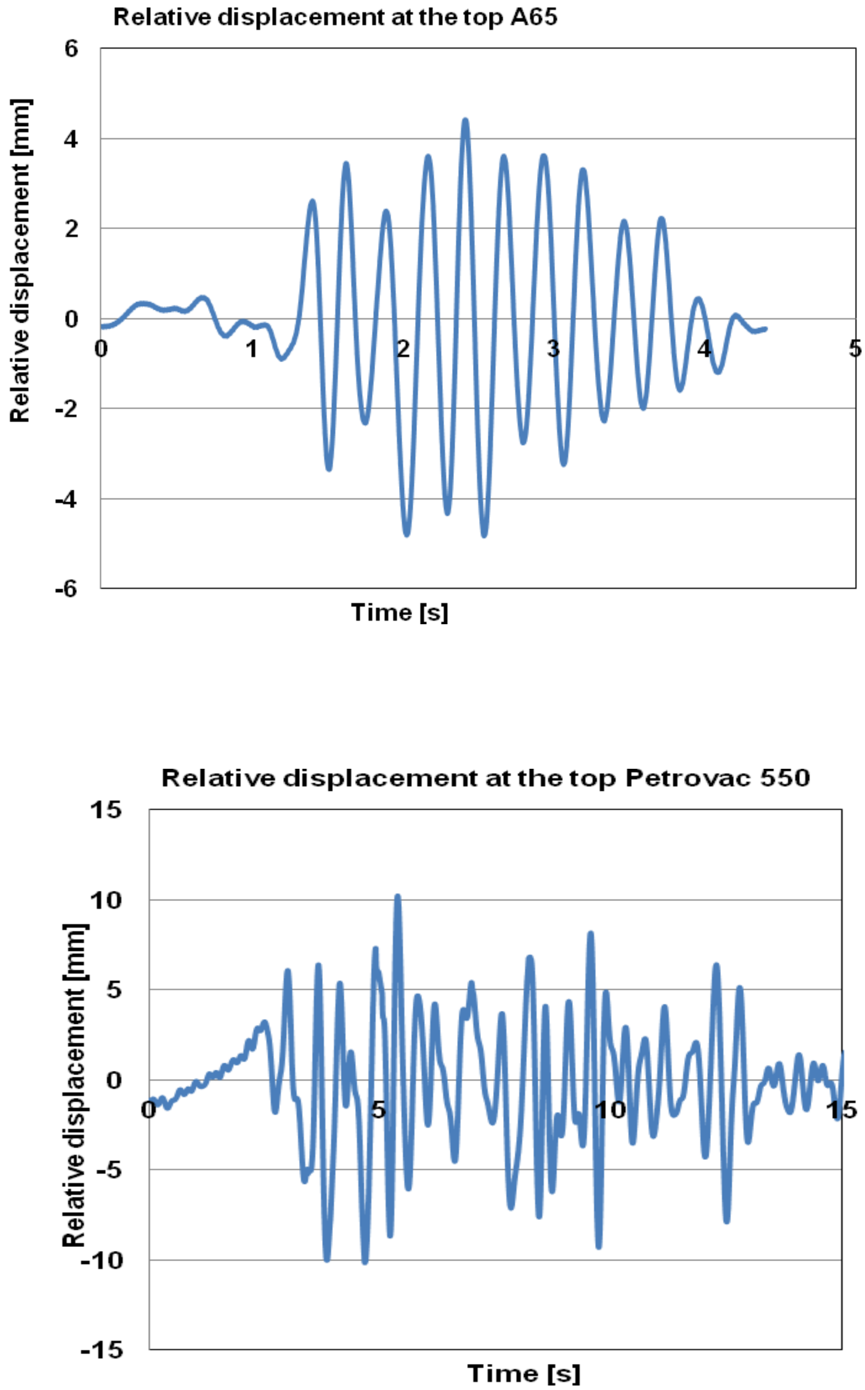

Figure 4: Relative displacements at the top of the panel for selected EQ records

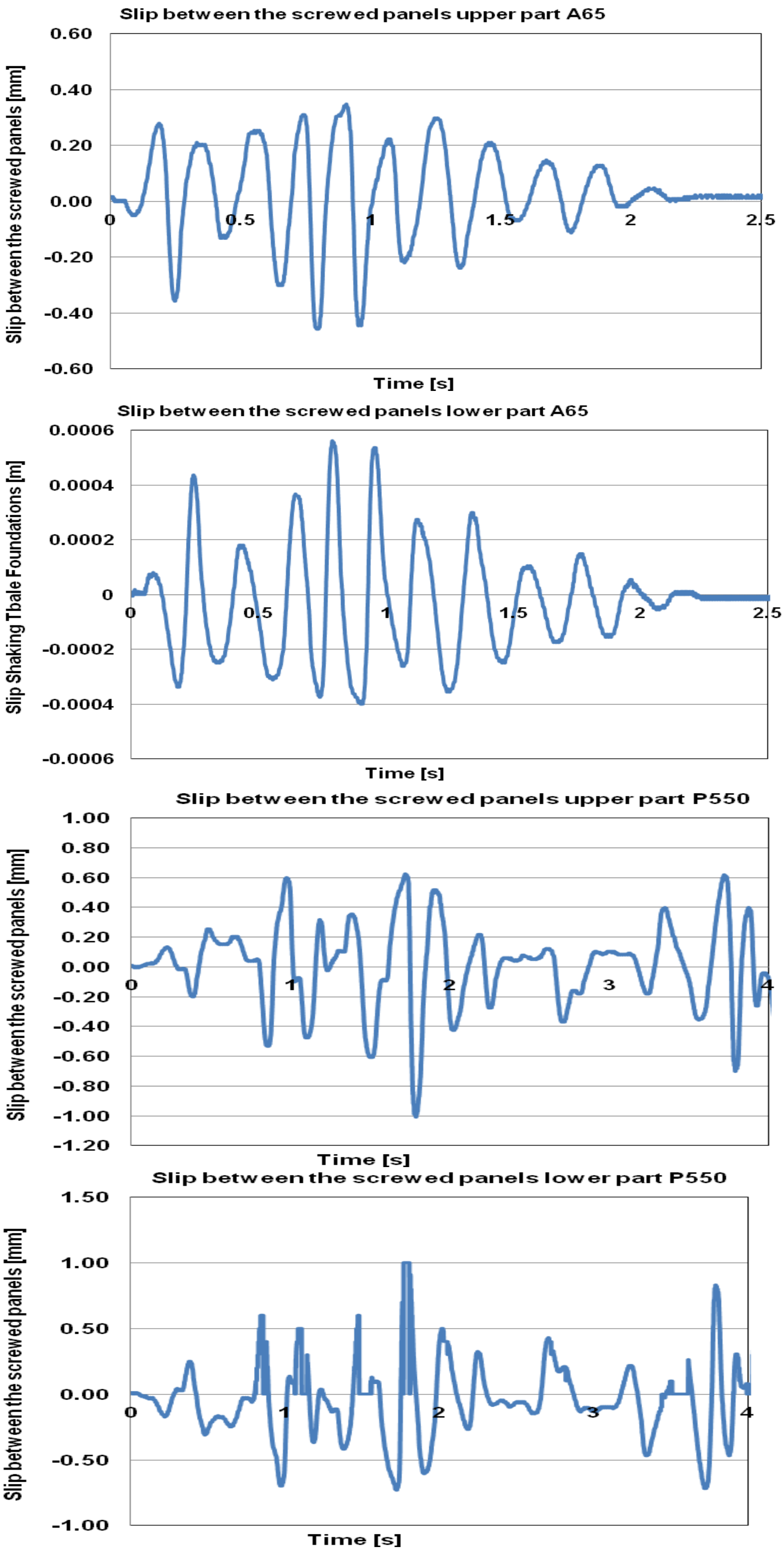

Figure 5: Slip between the vertically screwed units for selected EQ records

4. CONCLUSIONS

In this paper, the preliminary results from the shaking table tests preformed on a Xlam wooden specimen are presented. The XLam panels that compose the system were assembled by screwing together two separate elements with a length of 122 cm and a height of 272 cm. The tested specimen survived all the applied earthquakes, acting almost as a rigid body. As some of the previous investigations in this filed showed, the connections appear to be the main part of the XLam system that influences its overall behaviour. All the energy dissipation takes place in the steel anchors and the vertical screwed connections between the two wall units emphasizing the ductile behaviour of the specimen. More detailed discussions and analysis of the results are to follow.

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