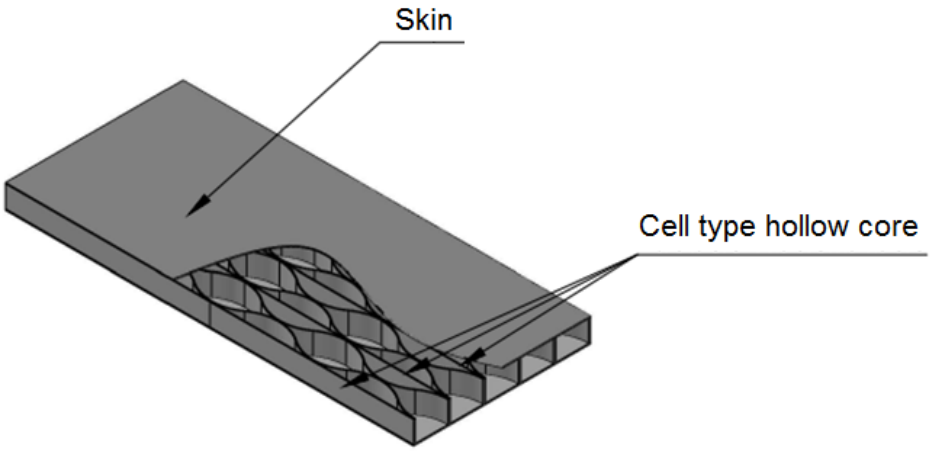
RIGA TECHNICAL UNIVERSITY

imateh

Layered wooden composite with rational structure and increased specific bending strength



Latvia state research program

"INNOVATIVE MATERIALS AND SMART TECHNOLOGIES FOR ENVIRONMENTAL SAFETY, IMATEH".

Project 4

Project leader: Kārlis Rocēns
Participants: J.Šliseris; Ģ. Frolovs; A.Kukule;

Riga, 2016

Team

Kārlis Rocēns

Jānis Šliseris

Ģirts Frolovs

Aiva Kukule

The aim of the project (2014-2017)

Development of load bearing layered wood composite with rational structure (Standard plywood plates do not have rational placement of material by its height and structure of layered material gives a chance to vary with placement of material at plates height), that provides increased specific bending stiffness (stiffness to weight ratio), reduced costs, consumption of materials and energy comparing to traditionally used materials. (LV Patent No. 14519)

Results of the project

	2014. – 2017.	2014.		2015.		2016.	
		Planned	Achieved	Planned	Achieved	Planned	Achieved
Scientific performance indicators							
1. Scientific publications:	6	0	0	1	4	2	5
number of original scientific articles (*SCOPUS*)(SNIP>1)	2	0	0	0	1	1	1
number of original scientific articles enclosed in magazines of the database *ERIH (A and B)* or in proceeding of conference articles	4	0	0	1	3	1	4*
number of reviewed scientific monographs	0	0	0	0	0	0	0
Economic performance indicators							
2. Number of applied for, registered, and valid patents or plant varieties in the framework of the programme:	1	0	0	0	2	1	2
in the territory of Latvia	1	0	0	0	2	1	2

* - accepted for publication

Scientific Publications

Scientific Journals:

1. J.Sliseris, H.Andrae, M.Kabel, O.Wirjadi, B. Dix, B.Plinke. ***''Estimation of fiber orientation and fiber bundles of MDF''*** Materials and Structures, 2015, ISSN 1359-5997, 1-10 lpp.

2. J.Sliseris, H. Andrä, M. Kabel, B.Dix, B. Plinke. ***''Virtual characterization of MDF fiber network''*** European Journal of Wood and Wood Products http://link.springer.com/article/10.1007/s00107-016-1075-5

Conferencen proceedings:

1. Sliseris J., Gaile L., Pakrastins L. ***''Non-linear buckling analysis of steel frames''*** "Advanced Construction" in Kaunas, Lithuania on 6-7 October, 2016

2. Frolovs G., Rocens K., Sliseris J**.** ***''Shear and tensile strength of narrow glued joint depending on orientation of plywood plys''*** 12th international conference "Modern Building Materials, Structures and Techniques" in Vilnius, Lithuania, on 26–27 May, 2016.

3. Kukule A., Rocens K., Lukasenoks A., Frolovs G. ***''Change of Moisture Distribution in Ribbed Plate with Different Opposite Surface Temperatures''*** 12th international conference "Modern Building Materials, Structures and Techniques" in Vilnius, Lithuania, on 26–27 May, 2016.

4. Sliseris J., Gaile L., Pakrastins L. ***''Deformation process numerical analysis of T-stub flanges with pre-loaded bolts''*** 12th international conference "Modern Building Materials, Structures and Techniques" in Vilnius, Lithuania, on 26–27 May, 2016.

5. Frolovs, G.; Rocens, K; Sliseris, J. ***"Comparison of a load bearing capacity for composite sandwich plywood plates"*** Environment. Technology. Resources. Proceedings of the 10th International Scientific and Practical Conference. Volume 1 June 18-20, 2015 Rezekne, Latvia pp. 39-45; ISSN: 1691-5402

6. Frolovs, G.; Rocens, K; Sliseris, J. ***«Glued Joint Behavior of Ribs for Wood-Based Composite Plates»*** 2nd International Conference „Innovative Materials, Structures and Technologies" , Riga, Latvia, 30.09-02.10.2015. (Accepted for Publication)

7. Rocens, K; Kukule, A. **«Prediction Of Moisture Distribution In Closed Ribbed Panel For Roof»** 2nd International Conference „Innovative Materials, Structures and Technologies" , Riga, Latvia, 30.09-02.10.2015. (Accepted for Publication)

Results of the project

	2014.–2017.	2014.		2015.		2016.	
		Planned	Achieved	Planned	Achieved	Planned	Achieved
Scientific performance indicators							
2. In the framework of the project:							
number of defended doctoral thesis	1	0	0	0	0	0	0
number of defended master's thesis	3	0	0	1	2	1	1
number of defended bachelor's thesis	0	0	0	0	0	0	0

Involved Students

Doctoral thesis:

1. Ģ.Frolovs “ Calculations of Rational wooden composite structures and their elements”;

2. A. Kukule “Behaviour or plywood ribs in various conditions of moisture”.

Master thesis:

1. I. Ucelnciece “Impact of snow loads on different types of roof shapes”; (Supv. D. Serdjuks, Ģ. Frolovs) defended.

2. A. Žukovska-Kečedži, „ Wind load action depending on the roof’s shape”; (Supv. D. Serdjuks, A. Kukule) defended.

3. A. Levics ‘’3D printētā fibrbetona spiedes un lieces īpašību eksperimentāls salīdzinājums ar monolītu fibrbetonu. ‘’; (Supv. J.Šliseris), Aizstāvēts.

Bachelor thesis:

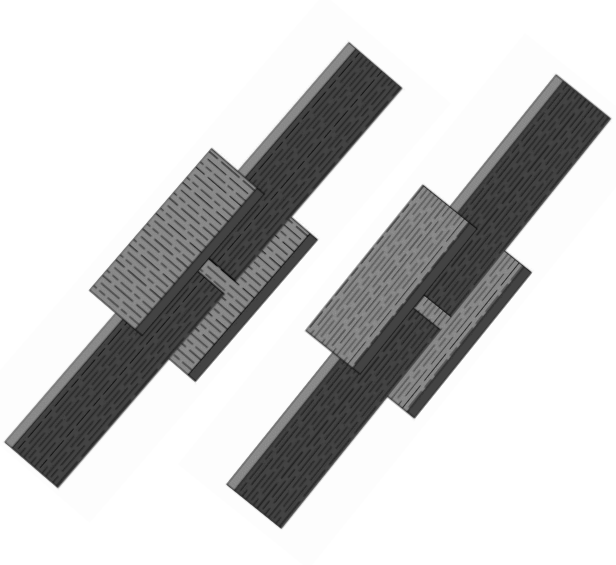
1. I. Matveja ‘’The validation and comparison of design methodology for plywood panels’’.

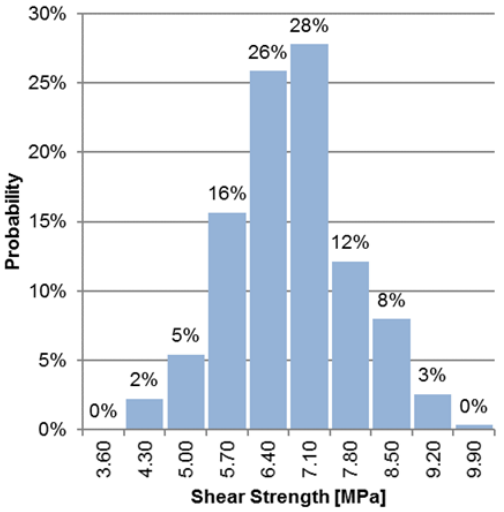
2. G. Švalbe, ‘’Trīsslāņu koksnes frēzbaļķa uzvedība mainīga mitruma apstākļos atkarībā no šķiedru orientācijas’’

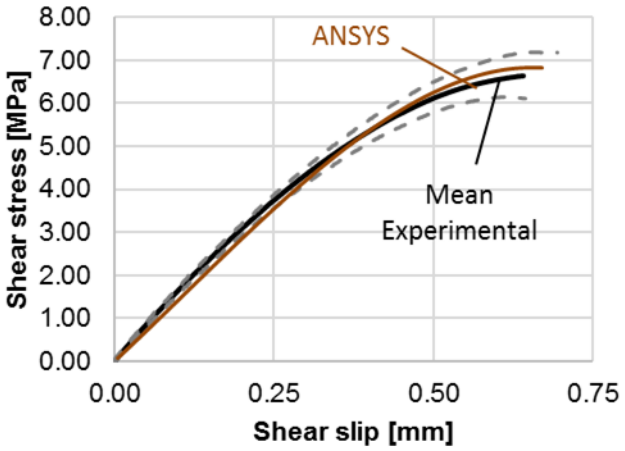
Tasks of phase 3

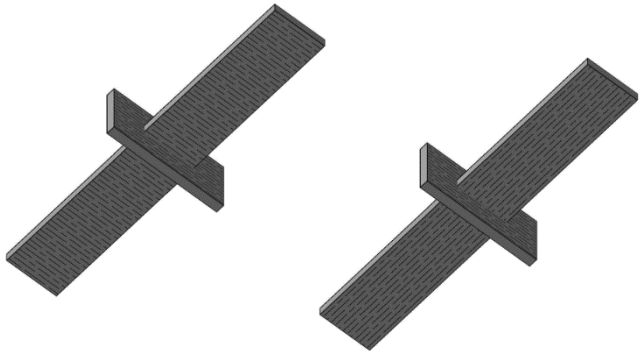
Tasks	Results
1. Methodology work-out for determination of bending strength and conceptual design of plates with cell type hollow ribs (end of task 2016. 1. quarter)	Achieved results show that for the constant thickness of a plate for ribbed plates the specific strength increases significantly in that way allowing to reduce material consumption for up to 20%.
2. Methodology work-out for determination of specific bending strength for plates with cell type hollow ribs and determination of values for the most typical geometrical parameters. (**end of task** 2016. 3. quarter)	Methodology work-out for determination of specific bending strength for plates with cell type hollow plywood ribs and plywood/MDF coverings for the most typical geometrical parameters.
3. Work-out plate models with most typical types of hollow cell type ribs and experimental investigations to get specific strength in bending, consumption of materials, energy consumption and costs. (**end of task** 2016. 4. quarter)	Determinate specific strength in bending, consumption of materials, energy consumption and costs for three types of models.

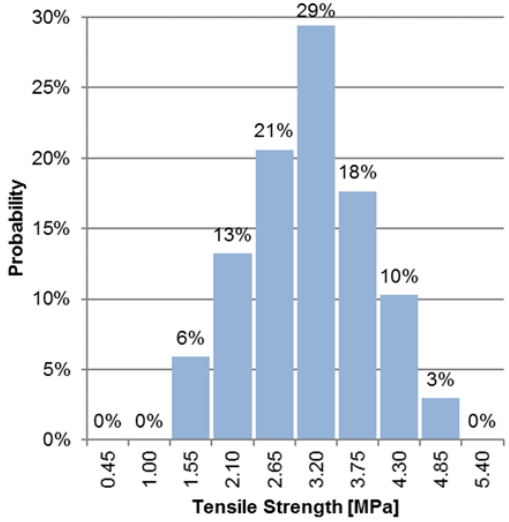
Test results

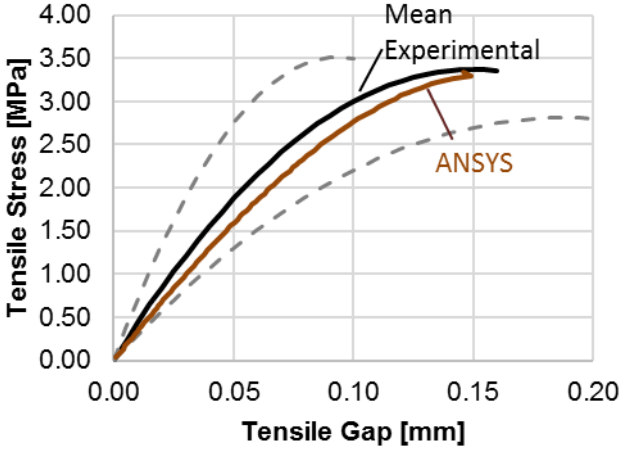








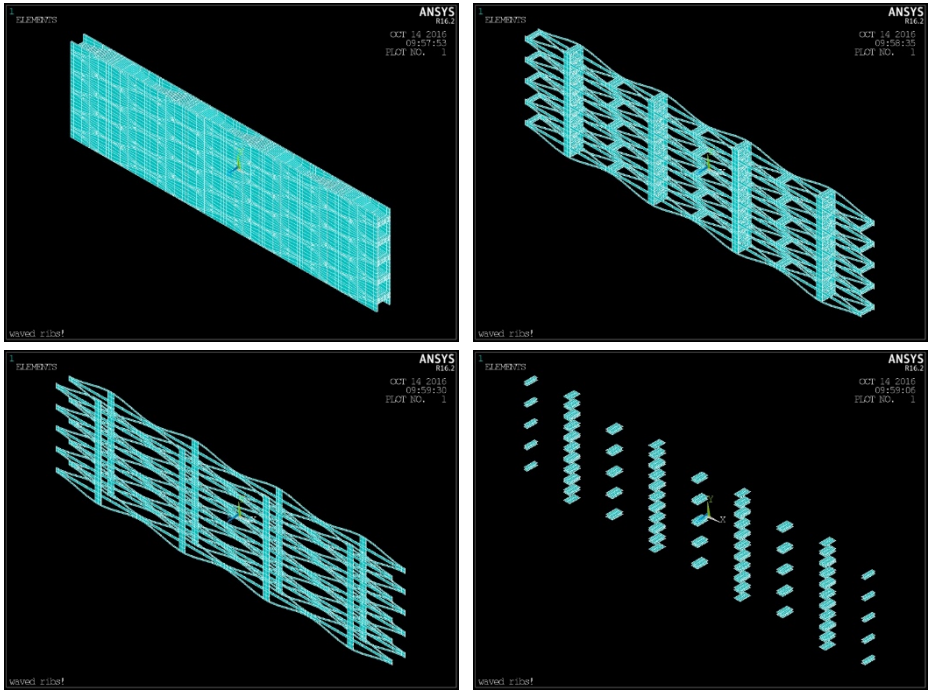




Plates with cell-type hollow core

FEM modelling

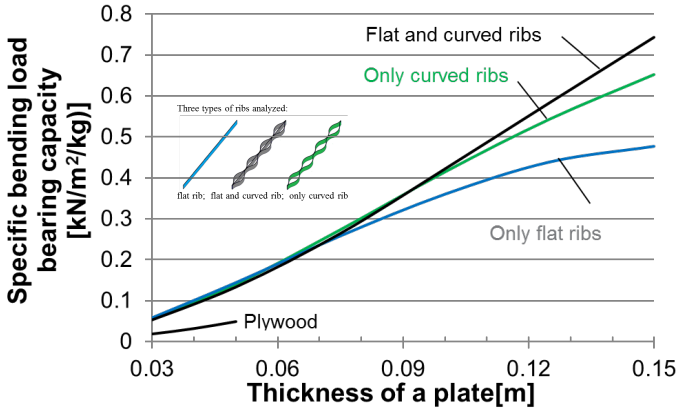
- Geometry
- Material properties
  - Failure Criteria
  - Contact Zone Material
- Deflection



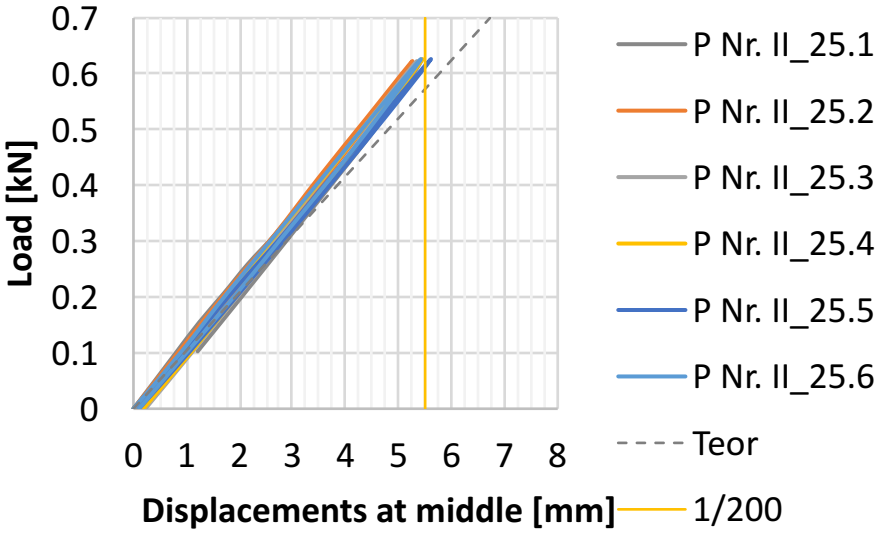
Experimental investigations

- Longitudinal direction
- Transversal direction
- «Short beam» tests

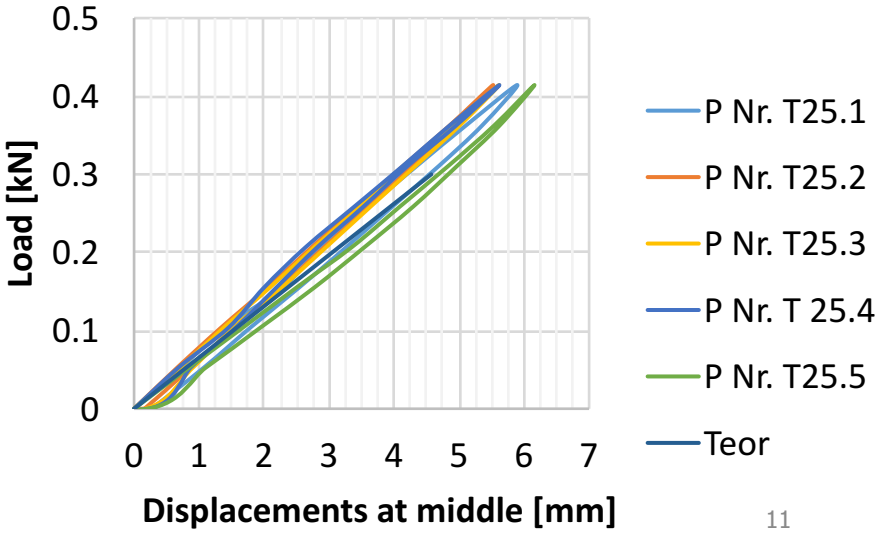
Experimental investigations



- Longitudinal direction



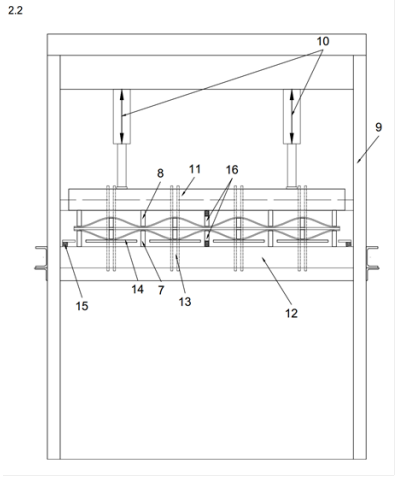
Transversal direction

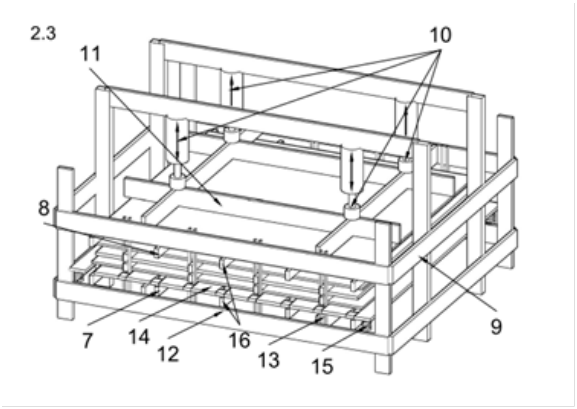


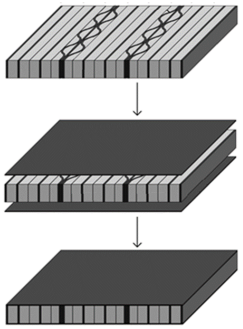
Patents

1. K. Rocens, G. Frolovs, A. Kukule, J. Sliseris „Method and equipment of production for ribbed composite plate with goffered wood-based core”, LV 15083A, The Official Gazette of the Patent Office of the Republic of Latvia, 20.12.2015, pp. 1749.

2. K. Rocens, A. Kukule, G. Frolovs, J. Sliseris, G. Berzins „Method for producing ribbed plates”, LV 14979B, The Official Gazette of the Patent Office of the Republic of Latvia, 20.06.2015., pp. 785.

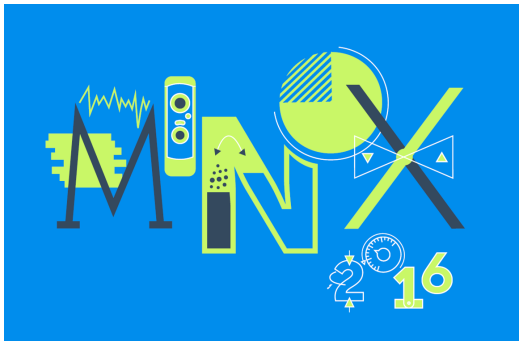






Awards

First place award at the ”6th International Invention and Innovation Exhibition MINOX 2016” Riga, Latvia 7th to 8th of October 2016



Tasks for phase 4 of project

Tasks	Results
Recommendations work out for design of geometrical parameters of plates with hollow cell type ribs.	Given recommendations for design of geometrical parameters of plates with hollow cell type ribs.
Recommendations' work out manufacturing and 'work in' technology principles and produce plates' demonstration models.	Technology principles for plates with hollow cell type ribs and production of plates' demonstration models.

Summary

The main results could be summarized following:

1. The methodology has been developed for plates with cell type hollow core and created program code for ANSYS FEM software in programming language (APDL) including non linear shear and tensile behavior of narrow glued line-joint between plywood surfaces and edges of ribs.
2. The experimental investigations were done and achieved that methodology describes the properties of plates with cell type hollow core and the coincidence to theoretically calculated is close enough to experimentally achieved.
3. The MATLAB code was created which automatically generates the input files for ANSYS FEM software providing possibility to calculate and optimize the stiffness and the load bearing capacity in bending of a plate depending on characteristics of materials and geometry of structure for the necessary load type and boundaries.

Thank you for attention !

Acknowledgement: The research leading to these results has received the funding from Latvia state research programme under grant agreement "Innovative Materials and Smart Technologies for Environmental Safety, IMATEH".

Izglītības un zinātnes ministrija

imateh

Studiju un zinātnes administrācija

ERANet-LAC Call Secretariat
Fundación Española para la Ciencia y la Tecnología

Dr. Janusz Mikuła
Coordinator of ELAC2015/T02-0721, FIBER

Madrid, 29 September 2016

Dear Dr. Mikuła,

On behalf of the Group of Funding Parties of the 2nd ERANet-LAC Transnational Joint Call on Research and Innovation, we would like to thank you for your participation in the Call and for your submission of the proposal ELAC2015/T02-0721 FIBER, "Development of eco-friendly composite materials based on geopolymer matrix and reinforced with waste fibers".

On behalf of the ERANet-LAC project, we are pleased to inform you that the proposal has been recommended for funding by the Group of Funding Parties. This recommendation is based on i) the peer review evaluation process, ii) the scientific assessment and ranking by the Scientific Evaluation Committee, and iii) the budgetary availability.

Please notice that the final grant, as well as the administrative part of the funding, is done at the national level and therefore relies on the successful accomplishment of the national procedure by each of the proposal's partners. As international coordinator, please kindly inform the partners accordingly.

We remain at your disposal should you wish further information on the Call.

With a warm congratulation,

Yours sincerely,

Cecilia Cabello
ERANet-LAC Call Secretariat

Main tasks (2014-2017)

To create a layered wooden composite with a rational structure, that provides increased specific bending strength, reduced costs and consumption of material and energy comparing to traditionally used wood materials. This includes following activities:

- to develop a new calculation method of bending load bearing capacity and conceptual experimental investigations of plates with hollow cell type ribs;
- to create a methodology of calculating specific bending strength of plates with cell type hollow ribs and determine values of specific load carrying capacity for ribs with most typical geometric parameters;
- to develop plate models with most typical types of hollow cell type ribs and experimental investigations to get specific strength in bending, consumption of materials, energy consumption and costs;
- to create recommendations for design of geometrical parameters of plates with hollow cell type ribs;
- to propose a manufacturing technology basic principles and produce plates' demonstration models;

Planned research outcome (2014-2017)

1. Methodology work-out for determination of bending strength and conceptual design of plates with cell type hollow ribs

   (result: 1 method);

2. Methodology work-out for determination of specific bending strength for plates with cell type hollow ribs and determination of values for the most typical geometrical parameters.

   (result: 1 method);

3. Work-out plate models with most typical types of hollow cell type ribs and experimental investigations to get specific strength in bending, consumption of materials, energy consumption and costs.

   (result: 3 type models);

4. Recommendations work out for design of geometrical parameters of plates with hollow cell type ribs.

   (result: 1 recommendation).

5. Recommendations' work out manufacturing and 'work in' technology principles and produce plates' demonstration models.

   (result: 1 technology principles)

Team schedule of the Project

Activities	2014.	2015.				2016.				2017.			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
1. Methodology work-out for determination of bending strength and conceptual design of plates with cell type hollow ribs	X	X	X	X	X	X							
1.1. work-out of calculation methodology	X	X	X	X	X	X							
1.2. determination of specimens' mechanical properties			X	X	X	X							
1.2.1 Resistance determination methodology of glue for joint between plywood surface and edge.			X	X	X								
2. Methodology work-out for determination of specific bending strength for plates with cell type hollow ribs and determination of values for the most typical geometrical parameters.				X	X	X	X	X					
2.1. work-out of calculation methodology				X	X	X	X	X					
2.2. determination of specific bearing capacity						X	X	X					
3. Work-out plate models with most typical types of hollow cell type ribs and experimental investigations to get specific strength in bending, consumption of materials, energy consumption and costs.			X	X	X	X	X	X	X				
4. Recommendations work out for design of geometrical parameters of plates with hollow cell type ribs.								X	X	X	X		
5. Recommendations' work out manufacturing and 'work in' technology principles and produce plates' demonstration models.						X	X	X	X	X	X	X	X

Results of Project

	2015.				2016.				2017.			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
6. Scientific publications:				1			1	1		1	1	
6.1. number of original scientific articles (*SCOPUS*)								1			1	
6.2. number of original scientific articles enclosed in magazines of the database *ERIH (A and B)* or in proceeding of conference articles				1			1			1		
7. In the framework of the project:				1			1				1	1
7.1. Doctoral thesis												1
7.2. Master thesis				1			1				1	
8. Performance indicators of the promotion of the		2		1		1	1			1	1	
8.1. Conferences		1		1		1	1			1	1	
8.2. Organized seminars		1				1				1		
8.3. popular-science publications												