LAMINATED WOODEN STRUCTURE OF THE GIPSY
ENTERTAINMENT CENTRE IN MOSCOW

Miljenko Haiman 1, Nenad Turčić 2, Krunoslav Pavković 3,

ABSTRACT: This paper presents the built glulam wooden structure of the Gipsy entertainment centre in Moscow. It is a rounded framework consisting of laminated frames with different shapes and spans covering a total area of around 1350 sq m with an irregular plan.

The investor required the structure to be completed as soon as possible so that the centre could be put back into operation. Construction activity was planned to last during October and November 2012. The dead line was extended for only 15 days because it was very difficult to meet the investors’ requirements.

The architectural solution was changed several times and was finally adopted late in September 2012. The structural analysis was carried out simultaneously with workshop drawings which were made within 12 days. By the end of October until the 10th of November all glulam wooden elements of the structure were made in factory in Slovenia. Assembly at the building site began in the in mid-November and was completed in early December when the cover membrane was mounted.

The centre reopened on 14th of December, 2012. This paper presents details of the structural analysis as well as proofs of the buckling stability of the structure modelled using COSMOSM FEA software. Also the joints for continuation of girders that were necessary due to transport in the trucks measuring 13.65 m will be shown. All elements had to be smaller than the length of the cargo space.

KEYWORDS: Glulam structure, FEA COSMOSM modelling, connecting details, fast building

1 INTRODUCTION

The new laminated wooden structure of the Gipsy Entertainment Centre in Moscow was due to be completed within 45 days at the investor's request. The design process started in early September, 2012. The site and the scope of the whole project were given. The structure was planned to be put up at the site of the existing entertainment centre which had to undergo a thorough renovation. The existing structure was planned to be entirely removed and a new light laminated wooden structure was designed to be superimposed on the steel grillage substructure placed at the height of approximately 7 m. A light removable covering made of double PVC UV fabric coating was designed as well.

This project was carried out by the designers from the Slovenian company DUOL while the numerical analyses and design of timber structural analysis were made by the authors of this paper. The Ljubljana-based HOJA Company was in charged for the production and the assembly of the laminated wooden structural elements.

The building site was in Moscow around 2000 km far from the place where the design process took place and where the laminated wooden elements were made. In such circumstances transport and construction speed was the main problem in the project realization. Truck transport was therefore seen as the optimal means of transport. The laminated wooden elements had to be designed to fit the standard truck cargo space measuring 2.45 x 2.9 x 13.6 m. These were the conditions which determined the details of the elements of the main load-bearing two-hinged arch structure including the details of the extensions as will be thoroughly presented in this paper.

2 MAIN LOAD-BEARING STRUCTURE

The main load-bearing structure is made of laminated wooden two-hinged arches supported by a steel substructure. The spans vary from 6.22 m, 17.67 to 23.60 m. The radius of the curved parts of the arches are

---

1 Miljenko Haiman, PhD. MSc CEng., Associate Professor, Faculty of Architecture, University of Zagreb, Croatia. e: mhaiman@arhitekt.hr
2 Nenad Turčić, MSc. CEng., Assistant Lecturer, Faculty of Architecture, University of Zagreb, Croatia. e: nenad.turcic@arhitekt.hr
3 Krunoslav Pavković, PhD. MSc. CEng., Assistant Lecturer, Department of Civil Engineering Polytechnic of Zagreb, Croatia. e: krunoslav.pavkovic@tvz.hr
minimally 300 cm. The timber used is the European spruce, category GL 28c according to EC5.

The designers conceived several possible versions of the placement of the structure such as its parallel placement to the substructure, or the two naves standing perpendicular to each other in plan whereas the substructure is cantilevered over the edges of the building which was not constructed at right angle (Fig. 1).

We opted for the solution according to which the structure is symmetrical to E axis which is the penetration line of the two naves. Thus the arches in lines 5 and 16 are equal.

The rambling plan (Fig. 1) shows that some parts of the existing structure, which could not be demolished, remained intact and were by-passed by the new structure. The final solution thus contains about 10 geometrically different arches.

![Figure 1](Plan of the structure)

We always perform an in-depth analysis of the wooden structure by means of FE analysis in the COSMOSM software. We have here also made a 3D numerical model as well as static and buckling analyses of load-bearing capacity and stability of the structure.

The modelling was carried out by SHELL4L elements which can be used to model the surface wooden girders with the input of wood’s orthotropic characteristics into the analysis.

Widths of the cross-sections of glulam girders are different between 18 and 28 cm. The height of the cross-sections of all girders is 100 cm. The axial spaces among the girders are shown in Figure 2 and vary between 450 and 480 cm.

The lateral stability of the structure is achieved by braces with tensile cross diagonals which are positioned at half the height in relation to their cross-section height, so that the bracing elements would not interfere with the covering made of PVC fabric coating on the external and the internal side of the roof surface. The numerical analysis was carried out for the combination of dead load and maximum snow load.

All principal and shear stresses are checked. Also the buckling analysis was done.

3 CONCLUSION

This structure, which was designed and erected by the joint effort of the experts from Ljubljana, Zagreb and Moscow in no more than three and a half months, clearly demonstrates the possibility of a fast construction process when using laminated wood despite great distances.

Of course, the whole process was facilitated by IT communication possibilities but also by the willingness of the building contractors to organize the whole process on time. We are proud to say that the entertainment centre reopened on 14 Dec 2012, just a few days behind the scheduled date due to bad weather conditions.

It should be also emphasized that the structure, which was designed to withstand high snow loads, was constructed only with 0.096 m3/m2 of glulam wood as well as with 5.6 kg steel/m2.

![Figure 2](Opening day, photo. The steel posts supporting the glulam girder in line E are camouflaged in the palm trees.)