Arc-flow formulation for a two-stage two-dimensional dual bin packing problem for wood reuse

Pauline Bessemans, Célia Paquay, and Morgane Dumont
University of Liège, HEC Liège Management School
QuantOM, Research Centre for Quantitative Methods and Operations Management
e-mails: pauline.bessemans@uliege.be, cpaquay@uliege.be, morgane.dumont@uliege.be

January 16, 2026

The increasing demand for raw materials such as wood undoubtedly contributes to the depletion of natural resources and global warming. To curb this phenomenon, a more sustainable and circular management of wood could be developed through the more efficient management of wood waste. This wood waste can be in the form of beams or pallets and could be considered as wooden slats. These slats could be combined, assembled, and glued to build Cross-Laminated Timber (CLT) panels for the construction industry, as shown in Figure 1.

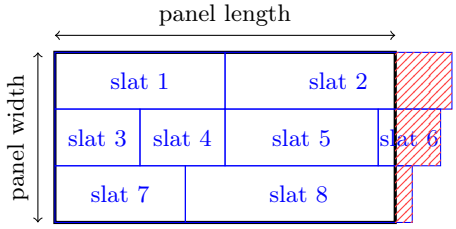

Figure 1: Toy example of assembly scheme to build one CLT panel

We aim to develop optimization techniques to recycle raw wood waste to create two-dimensional CLT panels of variable dimensions. The input waste is in the form of slats with variable and heterogeneous lengths and widths, but constant thickness. After a review of the Cutting & Packing literature, we identify our problem as an exact case of the two-stage two-dimensional multiple bin size dual bin packing problem (E-2S-2D-MBSDBPP) (1; 2) in the context of wood reuse optimization.

We propose a description of the problem and an arc-flow formulation with cuts, adapted from (5), (3), and (4). The algorithm provides the assembly schemes that maximize the amount of wood reused through the production of CLT panels. Finally, we present the results of several numerical experiments based on realistic instances from the wood industry obtained by using Gurobi's B&B procedure.

Keywords: Dual bin packing, Cutting and Packing, Arc-flow formulation, Combinatorial Optimization

References

[1] Assmann, S. F., Johnson, D. S., Kleitman, D. J., & Leung, J.-T. (1984). On a dual version of the one-dimensional bin packing problem. *Journal of Algorithms*, 5(4), 502–525.

[2] Gilmore, P. C. & Gomory, R. E. (1965). Multistage cutting stock problems of two and more dimensions. *Operations research*, 13(1), 94–120.

[3] Martinovic, J., Delorme, M., Iori, M., Scheithauer, G., & Strasdat, N. (2020). Improved flow-based formulations for the skiving stock problem. *Computers & Operations Research*, 113, 104770.

[4] Mrad, M. (2015). An arc flow-based optimization approach for the two-stage guillotine strip cutting problem. *Journal of the Operational Research Society*, 66(11), 1850–1859

[5] Valério de Carvalho, J. (1999). Exact solution of bin-packing problems using column generation and branch-and-bound. *Annals of Operations Research*, 86(0), 629–659