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Design of automated warehouse for long and heavy load steel bars

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Abstract

In this paper, design and operation of automated warehouse for long and heavy load steel bars of a steel production company, will be presented. A steel production company produces steel bars and has a large assortment of the end products with several dimensions and material properties. The steel bars are stored on the floor in a stacking frame (Figure 1). For the order picking of steel bars, an overhead (bridge) crane is used mainly for reshuffling all the necessary steel bars to get access to the required product [1-3]. While the production schedule allows for anticipating the storage occupancy, a stochastic transport arrival prevents optimal product stacking for efficient order-picking operation. Accordingly, any order-picking sequence may result in reshuffling of the stacked material which increases labour cost, order-picking times, and complicates material traceability. In order to decrease the labour costs, order-picking times and to improve material traceability steel bars can be stored in a fully automated honeycomb system with the use of automatic storage and retrieval machine (Figure 2). While majority of literature considers unit- or mini-load automated storage and retrieval systems [4-21] this paper considers long and heavy load steel bars due to different warehouse capacity and real operating characteristics of the storage and retrieval machine. For the design and operation of automated warehouse following methods have been used: observation, measurements, non-structured interviews (to obtain data from practice), modelling, optimization, statistical analysis, etc. Tools such as AutoCAD, MathLab, MS Excel, OptiMax and other open source tools have been used for the design and for the performance analysis.

Keywords: Material Handling Systems, Warehouses, Material Flow, Design, Analytical Modelling, Performance Analysis.

Fig. 1. Stacking frame for sets of steel bars.

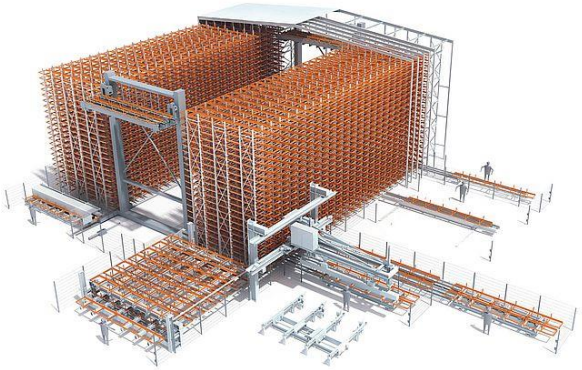

Fig. 2. KASTO automated honeycomb system.

References

1 **Kim K.H. and Hong, G.**: *A heuristic rule for relocating blocks*, Comput. Oper. Res. 33 (2006), 940-954.

2 **Tang, L.X., Liu, J.Y., Rong, A.Y. and Yang, Z.H.**: *Modelling and a genetic algorithm solution for the slab stack shuffling problem when implementing steel rolling schedules*, Int. J. Prod. Res. 40 (2002), 1583-1595.

3 **Tang, L., Zhao, R. and Liu J.**: *Models and algorithms for shuffling problems in steel plants* Naval Research Logistics, 59 (7) (2012), pp. 502-524.

4 **Lerher, T., Šraml, M., Potrč, I., Tollazzi, T.**: *Travel time models for double-deep automated storage and retrieval systems*. International Journal of Production Research, vol. 48(11), pp. 3151–3172, 2010.

5 **Gudehus, T.**: *Principles of order picking: Operations in distribution and warehousing systems*. Essen, Germany: W. Girardet Verlag 1973.

6 **Hausman, H. W., Schwarz, B. L., Graves, C. S.**: *Optimal storage assignment in automatic warehousing system*. Management Science, vol. 22(6), pp. 629-638, 1976.

7 **Graves, C. S., Hausman, H. W., Schwarz, B. L.**: *Storage retrieval interleaving in automatic warehousing system*. Management Science, vol. 23(9), pp. 935-945, 1976.

8 **Bozer, A. Y., White, A. J.**: *Travel-time models for automated storage and retrieval systems*. IIE Transactions, vol. 16(4): pp. 329-338, 1984.

9 **Hwang, H., Lee, S. B.**: *Travel time models considering the operating characteristics of the storage and retrieval machine*. International Journal Production Research, vol. 28(10), pp. 1779–1789, 1990.

10 **Lerher, T.**: *Model for designing automated storage and retrieval systems.* Ph.D. dissertation. Faculty of mechanical engineering, University of Maribor, 2005.

11 **Lerher T., Potrč I.**: *The Design and Optimization of Automated Storage and Retrieval Systems*. Strojniški vestnik, Journal of Mechanical Engineering 52(5), pp 268-291, 2006.

12 **Oser, J., Garlock, P.**: *Technology and throughput of double-deep multi-shuttle AS/RS.* Progress in Material Handling Research, vol. 5, pp. 409-423, 1998.

13 **Oser, J., Ritonja, M.**: *Expected cycle time in class-based single and double-deep storage system.* Progress in Material Handling Research, vol. 8, pp. 310-325, 2004.

14 **Sari, Z., Saygin, C., Ghouali, N.**: *Travel-time models for flow-rack automated storage and retrieval systems.* International Journal of Advanced Manufacturing Technology vol. 25(9/10), pp. 979-987, 2005.

15 **Bartholdi, J., J., Hackman, S., T.**: *Warehouse and distribution science*. USA: Georgia Institute of Technology, http://www.warehouse-science.com/, accessed 22.04.2019.

16 **Diao, X., Li, H., Zeng, S., WY Tam, V., Guo, H.**: *A Pareto multi-objective optimization approach for solving time-cost-quality tradeoff problems*. Technological and Economic Development of Economy, vol. 17(1), pp. 22-41, 2011.

17 **Lerher T., Borovinšek, M., Šraml, M.**: *A multi objective model for optimization of automated warehouses*. Logistics: perspectives, approaches and challenges, Nova Publishers, Inc., New York, pp. 87-110, 2013.

18 **Lerher T.**: *Modern automation in warehousing by using the shuttle based technology. Automation Systems of the 21st Century: New Technologies, Applications and Impacts on the Environment & Industrial Processes.* Nova Publishers, Inc., New York, pp. 51-86, 2013.

19 **Bekker, J.**: *Multi-objective Buffer Space Allocation with Cross-entropy Method.* International Journal of Simulation Modelling, vol. 12(1), pp. 50-61, 2013.

20 **Smew, W., Young, P., Geraghty, J.**: *Supply Chain Analysis Using Simulation, Gaussian Process Modelling and Optimization.* International Journal of Simulation Modelling, vol. 12(3), pp. 178-189, 2013.
21 **Zrnić, Đ., Savić, D.**: *Simulation of processes in material handling (Simulacija procesa unutrašnjeg transporta)*. Faculty of Mechanical engineering, University of Belgrade, Belgrade, 1997, ISBN: 86-7083-166-X.