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Designing a warehouse internal layout using a parabolic aisles based method

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ABSTRACT

Refined layout is a basis of warehousing efficiency. Straight aisle is a typical feature of current warehouse internal layouts. The purpose of this paper is to explore the possibility of using curve aisles for warehouse layout. By Choosing typical non-traditional layouts and transforming their inclined cross-aisle trajectory into parabola, two parabolic aisle layouts, parabolic Flying-V and parabolic Fishbone, are constructed. For unit-load warehouses, based on the morphological characteristic analysis and the parabolic types selection, the picking distance model and the cross-aisle length formula are presented. Interval Numerical Simulation Method (INSM) and Genetic Algorithms (GA) are adopted to solve the model respectively in order to verify the results. This research breaks through the realistic situation of straight aisle leading warehouse layout, and enriches the relevant layout theory. The calculation results of 100 warehouses with different sizes show that the picking distance of parabolic Flying-V could be reduced by 0.22-0.62 % compared with the straight layout, and the theoretical possible improvement space has been compressed by 2.42-12.26 %. Its length of cross-aisle is shortened by −0.03-3.10 %. The picking distance of parabolic Fishbone could be only reduced by 0.02-0.04 %. The theoretical possible improvement space has been compressed by 1.27-1.83 %. But its length of cross-aisle will increase by 4.63-19.50 % significantly. We believe that the layout of non-rectangular complex special-shaped warehouses based on curve trajectory aisles would become an important research topic. In addition, after some necessary modifications to the objectives and constraints, the proposed method in this paper may also be used for the arrangement of machines and devices in a workshop in principle.

ARTICLE INFO

Keywords:
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Layout efficiency;
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Oblikovanje notranje razporeditve skladišča z metodo paraboličnih prehodov

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POVZETEK

Premišljena postavitev je osnova učinkovitosti skladiščenja. Ravni prehodi so tipična značilnost trenutnih notranjih razporeditev skladišč. Namen tega prispevka je raziskati možnost uporabe ukrivljenih prehodov za postavitev skladišča. Z izbiro tipičnih postavitev in s preoblikovanjem trajektorije ravnega prehoda v parabolo smo ustvarili dve paraboličnih postavitvi prehoda, parabolični leteči-V (angl. Flying-V) in parabolična ribja kost (angl. Fishbone). Za paletna skladišča sta na podlagi analize morfoloških značilnosti in izbire paraboličnih tipov predstavljena model razdalje do regala in formula za razdaljo med regali. Metoda intervalne numerične simulacije (INSM) in genetski algoritem (GA) sta uporabljena za rešitev modela in pridobitev rezultatov. Ta raziskava nadgradi realistično stanje postavitve skladišča z ravnimi prehodi in obogati obstoječo teorijo postavitve skladišč. Rezultati izračuna 100 skladišč z različnimi velikostmi kažejo, da bi se razdalja do regala v primeru postavitve skladišča po načelu paraboličnega letečega-V lahko zmanjšala za 0,22–0,62 % v primerjavi z ravno postavitvijo, teoretični možni prostor za izboljšanje pa je bil stisnjen za 2,42-12,26 %. Razdalja med regali se skrajša za –0,03–3,10 %. Razdalja do regala v primeru paraboličnе ribje kosti se lahko zmanjša le za 0,02–0,04 %. Teoretični možni prostor za izboljšanje je bil skrčen za 1,27–1,83 %. Toda razdalja med regali se je znatno povečala za 4,63–19,50 %. Menimo, da bi postavitev nepravokotnih kompleksnih skladišč posebnih oblik na osnovi krivuljnih prehodov lahko postala pomembna raziskovalna tema. Ob vpeljavi potrebnih sprememb se predlagana metoda lahko uporabi tudi za razporeditev strojev in naprav v delavnici.

PODATKI O ČLANKU

Ključne besede:
Oblikovanje postavitve;
Notranja ureditev skladišča;
Parabolična postavitev prehodov;
Učinkovitost postavitve;
Simulacija;
Optimizacija;
Metoda intervalne numerične simulacije (INSM);
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