第５号様式

論文審査の要旨

博士の専攻分野の名称	博　士　（　工学　）	氏名	何　旻哲
学位授与の要件	学位規則第４条第[1]・２項該当		

論　文　題　目

Research on development of road engineering automated index detection equipment importing the circular economy strategies

（循環経済戦略を取り入れた道路工学自動指標検出装置の開発に関する研究）

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〔論文審査の要旨〕

The purpose of this research is to find out the best strategic planning model for the overall paving project. Through artificial intelligence and methodologies, engineers can find destroyed asphalt pavement of the road more quickly, know the best construction site to maintain, and cut down the completion day to save energy and reduce carbon emissions. The development of the real-time road patrol management system and lean management system can accelerate administrative efficiency and field management and reduce the waste of manpower, machines, and equipment, which makes the overall research strategy more efficient.

Chapter 1 presents the background, purposes, and methodology of this study.

Chapter 2 describes a literature review related to this thesis.

Chapter 3 presents the reduction of the impact of carbon emissions associated with the transport of materials in highway pavement construction projects. A sparse-coding support-vector (SCSV) methodology is employed to analyze four major indices of highway pavement: the international roughness index (IRI), structural number (SN), pavement condition index (PCI), and equivalent single-axle loads (ESALs). The energy-conservation and carbon-reduction efforts of construction vendors are also evaluated. The proposed model can be further generalized by employing a wider range of traffic data, additional roughness indices, and structural properties of pavement. An optimization scheme is formulated as a mixed-integer linear programming problem based on the time required for asphalt inspection using spatial networks and operating constraints.

Chapter 4 provides the addition of energy conservation and carbon reduction into

precasting concrete plants to improve the level of quality further. Application of the cost efficiency with the introduction of carbon calculator for the "carbon footprint" and lowering carbon emission strategies is further discussed. During the life cycle of the precasting structure, a good structure design incorporates not only the planning and design, but also its materials, equipment, and construction, which make up the important elements in preparing the final products in the precasting concrete plant.

Chapter 5 discusses the effects of frequent road inspections that are key to maintaining road quality and avoiding casualties associated with poor road conditions. This study developed back-end image recognition software using existing road inspection methods and equipment. This was aimed at enhancing inspection efficiency by enabling the automatic identification of road damage. The results of the proposed fully-automated method conform strongly with those obtained using semi-automated pavement inspection software. Despite the restrictions imposed by the limited depth measurement of 2D images, our method achieved results close to those obtained using manual inspection.

Chapter 6 examines the theoretical and analytical solutions concerning the industrial layout and vendor location of Taiwanese asphalt vendors by adopting the industrial location theory. The analysis was divided into a macro-analysis and a micro-analysis. The macro-analysis analyzed sectional and national industrial layout. The micro-analysis examined vendor choice theory. The analyses were based on the locations of the vendors along different national freeway sections. The outcomes were used to propose transport and labor location principals for the various sections. Finally, equal-cost charts were illustrated for the different sections to determine the optimal vendor location.

Chapter 7 estimates pavement performance indicators (i.e. IRI, ESALs, SN, and PCI) employing the SCSV method. Each parameter was entered one by one and brought together using seven different models. This resulted in a predictably high success rate to the value of the IRI. The proposed model allows the state of pavement to be estimated at present and in the near future in assisting scheduling maintenance projects. The proposed scheme is designed to minimize CO_2 emissions for a set quantity of repair materials. Likewise, the proposed scheme can be used to extend the length of road that could be repaired for a given amount of CO_2 emissions. Decision-makers can determine whether to enhance the efficiency of road work or to lower CO_2 emissions according to the results of the analysis. The proposed model could be generalized to a wider range of situations by including a wider range of traffic data, pavement structural properties, and roughness indices.

Chapter 8 states the conclusions of the thesis.

The examining committee evaluated that the dissertation met the standard of excellence expected of a doctoral candidate at Hiroshima University.