PDRG MEETING JRPUG 2022

Surface Properties and Human/Vehicle Interaction

Evaluation of Walkability on Walking Surfaces Using Electromyography

29-30, Oct, 2022 @Hokkaido University of Science



Kitami Institute of Technology,

Transportation Engineering Laboratory

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►Introduction

- Background and Objectives
- What is EMG? and Targeted Muscles

►Experiment

- Targeted Pavements
- Walking Test
- Measurement Devices

➤Analysis Methods

- Acceleration Analysis
- EMG Analysis
- ➤ Results

Contents.

- Introduction
 - Background and Objectives
 - No Clear Indicators
 - Aging Society
 - Growing Health Consciousness

Maintenance of
 <u>Pedestrian Space</u>



> Introduction

- What is EMG? and Targeted Muscles

Interpretation of EMG



- Targeted Muscles
- Gastrocnemius Medialis (hereafter, Gmh) - Walkability Index
- Tibialis Anterior Muscle (hereafter, Ta)
 - Stumbling Ease Index

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Experiment — Targeted Pavements



Dense Granular Asphalt

Grooves Cut



Thermal Barrier



Water Retention

Porous Asphalt



Polished Porous Asphalt



Block (Varying Joint Widths)

Experiment – Walking Test









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Experiment — Measurement Devices

Previous Research

Correlation between Muscle ⇔ Physical Properties Gmh ⇔ Slip Resistance Ta ⇔ Texture Depth →ASM(American Slip Meter) Measures the Coefficient of Slip Resistance of Building Flooring.

• Correlates with C.S.R Tester





←CTM(Circular Track Meter) Measuring Method of Pavement Texture Depth Using a Rotary Texture Depth Measuring Device



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Analysis Methods – Acceleration Analysis

Understanding Gait Dynamics

1.8Switch : ON Switch 0.8 **Acceleration Data** 1.6itch 9.0 i **Calculate Walking Cycle*** S 0.4 from Switch and **Acceleration Data** 1.2 0.2 To Myoelectric 0 Waveform Analysis Heel Lands Time[s]

Analysis using numerical analysis software MATLAB R2022a

MathWorks Homepage https://jp.mathworks.com/products/matlab.html

fig. Acceleration Waveforms



Walking Cycle*...from the time one heel lands on the ground until it lands again when walking

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*The time window was set to 0.03 seconds = 30 points (sampling frequency 1000 Hz). > Analysis Methods - EMG Analysis Gait Dynamics Obtained from Switch and Accelerometers 0.5 0.18 This study 1 Walking Cycle 1 Walking Cycle 1 Walking Cycle 1 Walking Cycle 0.4 0.16 0.3 0.14 Muscle Activity 0.2 0.12 $\sum_{\substack{\substack{ = \\ \underline{} 0.08}}}^{0.1}$ [mV]0.1 -0.1 -0.2 0.06 0.06 E 0.04 **Physical Properties** W/ 0.02 -0.3 -0.4 1001 501 1501 501 1001 1501 Time [ms] Time [ms] fig.(a) Raw Myoelectric Waveform fig.(b) Myoelectric Waveform after Smoothing Raw Data fig.(a) **Road Surface** Absolutization **Evaluation** Moving Average Smoothing Process* fig.(b) Integrate to Produce Muscle Activity

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> Results

Muscle Activity : Small

Comparison of Walkability Index and Physical Properties



Relative Comparisons were Made Based on Walking on Dense Granular Pavement



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Large

> Results

Muscle Activity : Small

Comparison of <u>Stumbling Ease Index</u> and Physical Properties



Relative Comparisons were Made Based on Walking on Dense Granular Pavement



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Large



Contributing to the Development of Walking Spaces that Everyone can Use Safely



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Thank you for your kind attention.

"Evaluation of Walkability on Walking Surfaces Using Electromyography"

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