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Development of the Vibration Absorption Caster-wheel for Wheelchair

--The effect of the vibration absorption and endurance --

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Introduction

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- Wheelchair users feel vibrations
  through caster & seat
- Vibrations lead discomfort
  make users get tired
- Needs of additional function: vibration absorbing
  on wheelchairs / casters
- Main cause of vibration is on the front casters
  (Rear wheel are air-tire)

→ Focus on front caster wheels

Introduction

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Caster Types

- **Air tire type:** adjustable hardness, comfort
  air leak, flat tire (puncture)

- **with Shock-absorber:** comfort, no-puncture,
  very expensive (about $160)

- **Low repulsive urethane:** comfort, no-puncture,
  still expensive (about $115)
  some of them are insufficient function

Introduction

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Development of inexpensive caster wheel

that has the function of vibration absorbing.

- **Material:** Low repulsive urethane
- **Price:** $50.00 /each or less
- **Main requirements:**
  1. **absorb vibration:**

     Ruggedness of 10mm height or less (5~8mm)
  2. **without increasing Running Resistance**
  3. **enough stiffness for Running Endurance**

Introduction

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In our previous research:

clarified the basic characteristics.

- **Function of vibration absorbing:**

  Passageway with bumps (indoor) → **good!**

  Stone paved roads (outdoor) → **good!**

- **Running resistance:**

  not increase so much (easy to propel)

→ **Well-balanced design !!**

How about Endurance ??

Objective

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Investigate the

running endurance of

the caster we have developed

Methods

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(A) Caster we developed (D=75mm)

(B) Urethane type 1 (D=75mm)

(C) Urethane type 2 (D=75mm)

(D) with shock-absorber (D=65mm)

(E) Normal solid caster (D=80mm)

Methods

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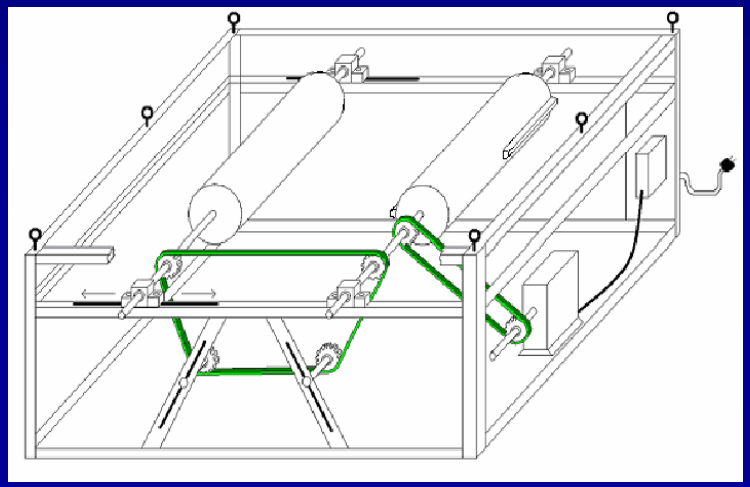
- **Running Endurance Testing Machine: (JIS-T9201)**
  - **double drums**
  - **driven by speed controlled motor**
  - **with bumps of 12mm height**
  - **200,000 machine's drum revolutions (157km)**
- **Fix the wheelchair on the testing machine**
  - **with dummy weight of 75Kg**



Methods

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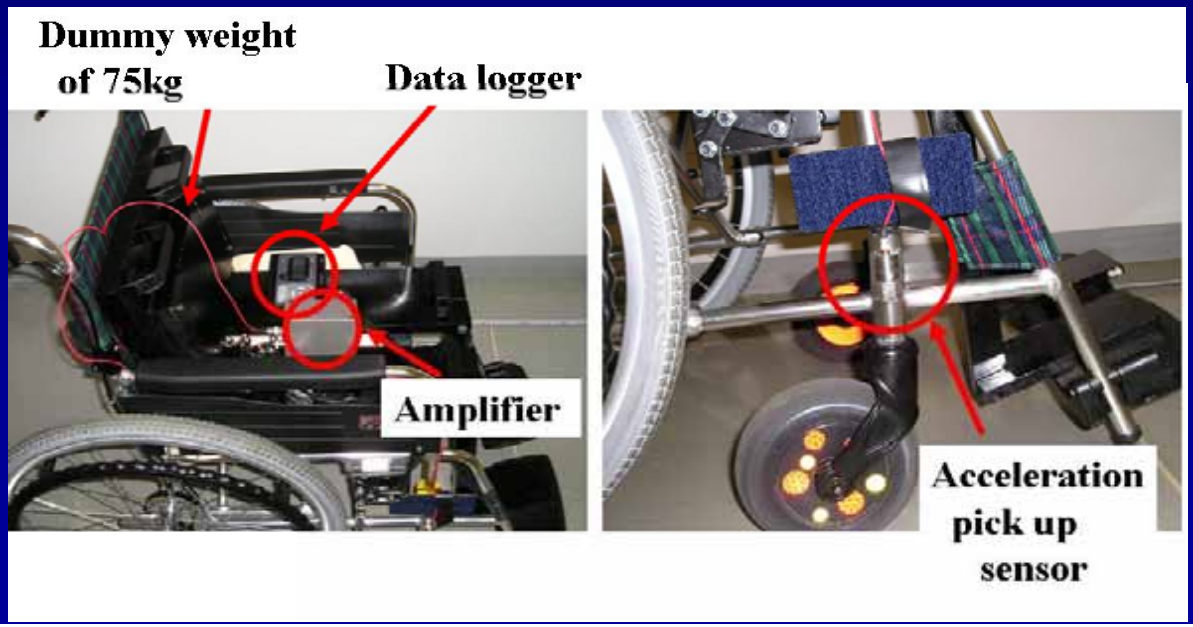
- **Acceleration Pick up Sensor:** TEAC 707LF (Max150m/s2) mounted on the housing frame of front caster
- **Amplifier:** TEAC SA-611
- **Data logger:** TEAC ES-8 (Max 2kHz)
- **Filter:** cut ~~0.2Hz(DC), 1kHz~~
- **MAA:** Maximum Amplitude of Acceleration (m/s2)



Results (visual observation)

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- Caster (A) : Tiny crack around interface of wheel and tire
- Caster (B) : none
- Caster (C) : none
- Caster (D) : none
- Caster (E) : wear-out, and scar on the surface

Caster (A)

Caster (E)

Results (MAA)

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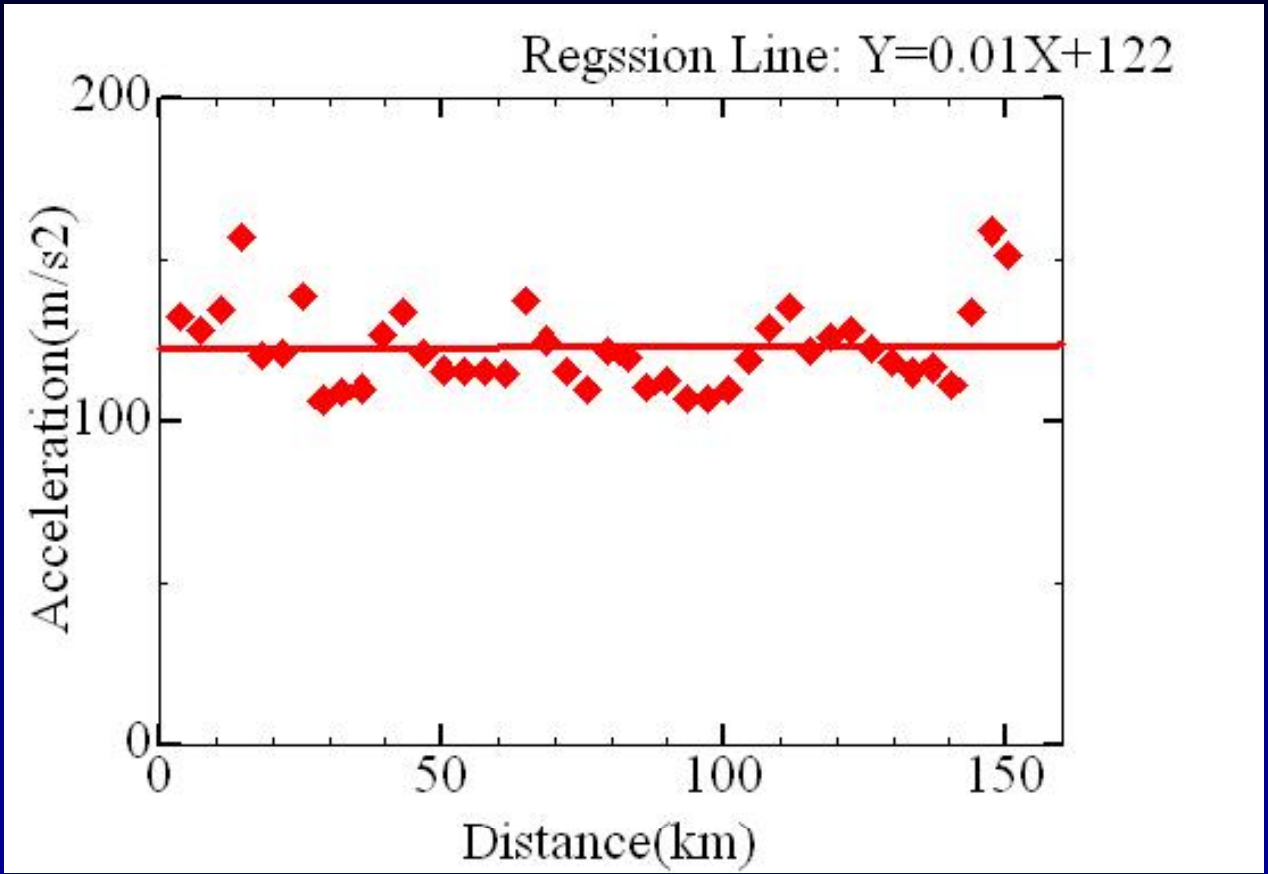
Caster E



- **MAA were ranged around 122m/s2.**
- **Almost flat data.**
  (not increase according to the increasing of mileage)

Results (MAA)

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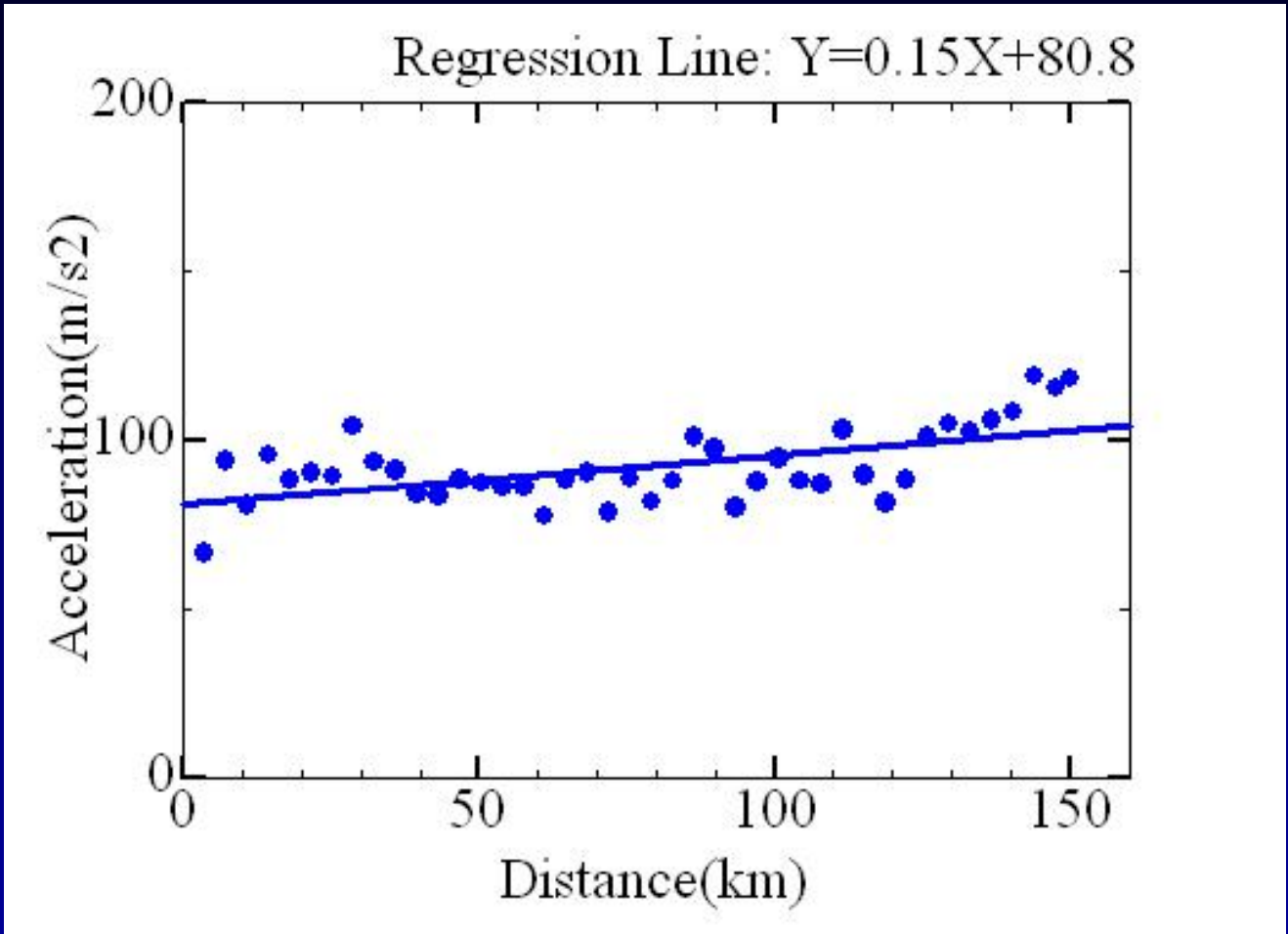
Caster A



- **Start from about 80m/s2, reach about 100m/s2.**
- **Reduce 15~35% of MAA against Caster(E).**
- **MAA increases according to the mileage.**

Results (MAA)

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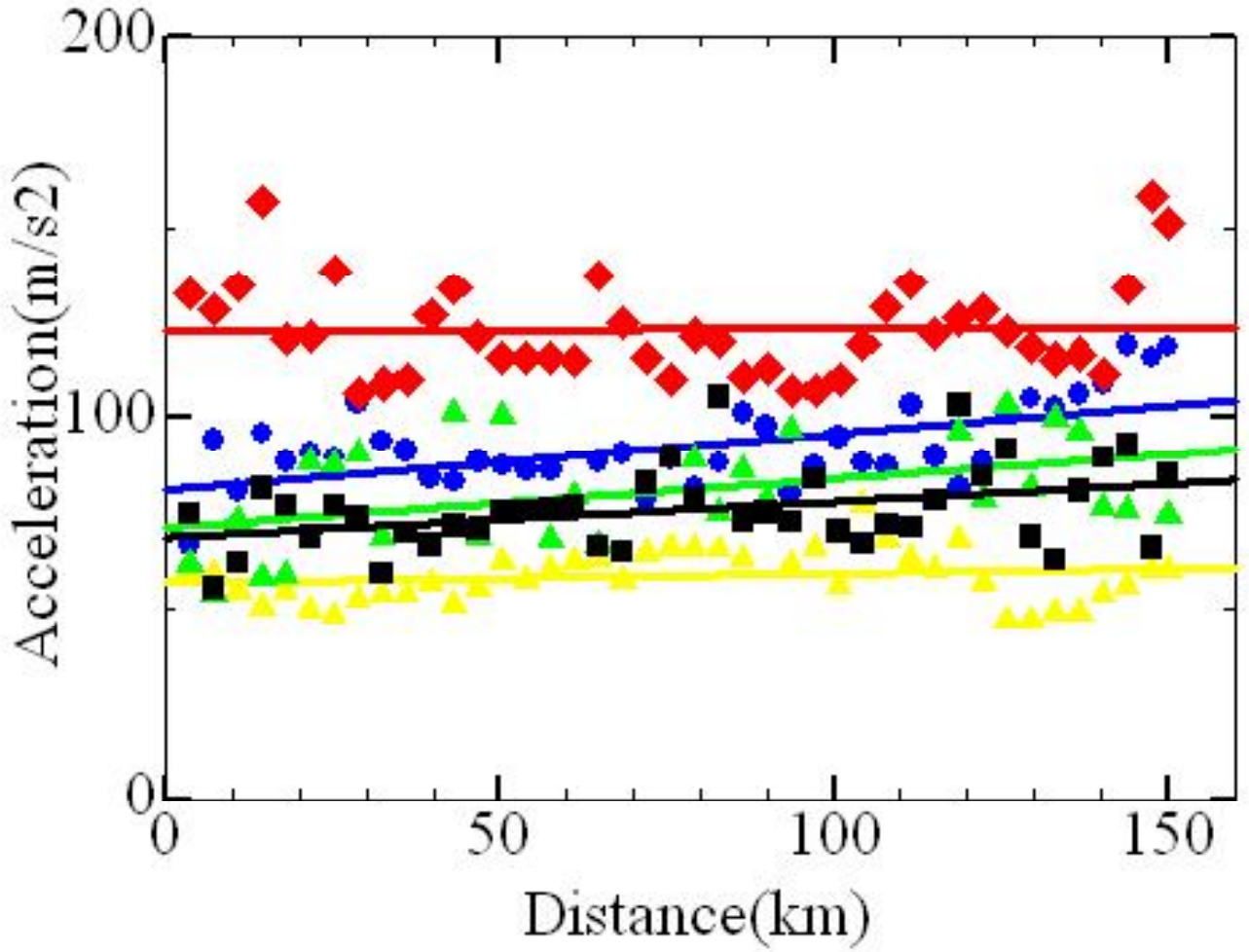

- **This results was dissatisfaction!**

Discussions

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- **In our previous research:**

Function of vibration absorbing: GOOD!

Passageway with bumps (indoor)

Stone paved roads (outdoor)

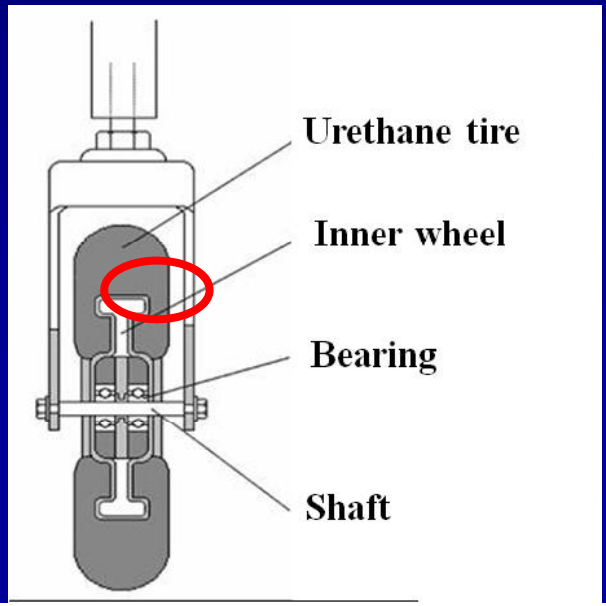
- **In this research (Running Endurance test):**

Function of vibration absorbing: not so good!

Why ???

Discussions

- Every crack were at the interface of tire and inner-wheel
- Thin urethane tire & too high bump (vs design spec.)
- **Rim of the inner-wheel hits into edge of the bump**
- **Urethane tire was damaged (crack)**
- Leads decreasing of the function



Discussions

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- **As the design specification:**

  absorb the vibration of 10mm height or less.

  (mainly 5~8mm)

- **The height of the bump of this test was 12mm.**

→Testing condition of 12mm height

was excess specification !?

Discussions

Re-arrange and re-produce new trial caster:

- **Thickness of Urethane tire → +3mm**
- **Diameter of inner wheel → -6mm**
- **Increase hardness of urethane tire**

Conclusions

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- **Investigate the running endurance of the caster we have developed.**
- **MAA had decreased 15~35%.**
- **MAA increases according to the mileage.**
- **The effect of the vibration absorption was not sufficient.**
- **Re-designing of thickness of tire and inner-wheel could be the solution.**

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Thank you !
有り難う！
Vielen Dank !
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Muchas gracias !
Grazie !
谢谢！
고맙습니다 !
Obrigado !
Köszönet !