Wayside Noise Reduction Technologies for Shinkansen High-Speed Trains in East Japan Railway Company

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11th July Session: Noise and Vibration
Content

- 1 Introduction
- 2 Noise Sources of Shinkansen
- 3 Countermeasures for Each Noise Source in JR East
- 4 Noise Reduction Devices for Series E5
- 5 Conclusions
**Introduction**

**Shinkansen Network of JR East**

**Conventional lines converted to Shinkansen gauge.** *(Mini-Shinkansen lines)*

- Akita line
- Yamagata line

**Hokuriku Line**
Scheduled for operation to Kanazawa from March, 2015

**Hokkaido Line**
Scheduled for operation to Hakodate from March, 2016

**Shinkansen lines**

- Tohoku line
- Joetsu line
- Nagano line

**Series**

- E3
- E4
- E2

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Introduction

Shinkansen Network of JR East

Conventional lines converted to Shinkansen gauge. (Mini-Shinkansen lines)

Series E3
(Max speed 275 km/h, Shinkansen line)
(Max speed 130 km/h, conventional line)

Series E4
Double-decker coach
(Max speed 240 km/h)

Series E5
(Max speed 320 km/h)

FASTECH360Z
It runs both on Shinkansen lines and on conventional lines.

FASTECH360S
It runs only on Shinkansen line.

High-speed test trains (Max speed 360km/h)

Series E2 (E2, E2-1000)
(Max speed 275 km/h)

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Noise Sources of Shinkansen

Aerodynamic noise from upper parts of cars
- Aerodynamic noise from the gaps between cars
- Noise generated from protrusions (bumps) of doors and windows

Aerodynamic noise from train nose
- Noise from the front bogie, the door of the driver’s cab, etc

Noise from lower parts of cars
- Aerodynamic noise around bogies
- Rolling noise from wheels

Pantograph noise
- Aerodynamic noise emitted from pantograph itself
- Sliding noise between overhead contact wire and pantograph

Structure-borne noise
- Noise induced by vibration of structure

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Contribution of each noise component (Series E2)

Pantograph noise is a major contributor to total noise at 360 km/h.

Overall noise

Overall noise level (275 km/h)

Noise from lower part of cars

Contribution to total noise at 360 km/h

Overall noise level (275 km/h)

Overall noise

Noise from lower part of cars

Pantograph noise

Aerodynamic noise from train nose

Noise from lower part of cars

Aerodynamic noise from upper part of cars

Pantograph noise

Structure-borne noise

Series E2 commercial trains

Contribution to total noise at 275 km/h

+6 dB

Overall noise level (275 km/h)

A-weighted sound pressure level (slow) [dB]
Reduction of noise from pantograph

PS207 type low-noise pantograph
(Existing pantograph, for Series E2)

PS9037
The component of this type is arranged to one side.

PS9038
This type has no mid-hinge (mid-hinge is located in a windscreen covers)
Countermeasures for Each Noise Source in JR East

Other measures for pantograph noise

Multi-Segment Slider

New pantograph head (multi-segment slider)

The multi-segment slider makes it easier to track the wire with a divided contact strip.

Operation using only one pantograph per train set

FASTECH360S

FASTECH360Z

Travel direction (northbound)
Countermeasures for Each Noise Source in JR East

Countermeasures for Other Noise Sources

**Sound-absorbing panels for lower part of cars**

- Lower side
- Underside

**Surrounding covers between cars**

- Noise Distribution Map
  - Conventional type
  - Circumferential type

The Measurement result in FASTECH360Z as mini-Shinkansen type high-speed test train

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Contribution of each noise component (FASTECH360S)

Overall noise level (Series E2-1000, 275km/h)

(a) E2-1000, 360km/h

(b) FASTECH360S, 360km/h

Overall noise (Total noise)
- Aerodynamic noise from train nose
- Noise from lower part of cars
- Aerodynamic noise from upper part of cars
- Pantograph noise
- Structure-borne noise

A-weighted sound pressure level (slow) [dB]

Time [s]
Measurement Results of Overall Noise at 25m

- **Overall noise weighted sound pressure level (slow) [dB]**
  - **FASTECH360S**: 5dB

**Countermeasures for Each Noise Source in JR East**

- **Overall noise level (Series E2-1000, 275km/h)**
  - **5dB**

**Measurement Results of Overall Noise at 25m**

- **A-weighted Sound Pressure Level [dB]**
  - **1dB**

**Train Speed [km/h]**

- **240**
- **260**
- **280**
- **300**
- **320**
- **340**
- **360**

**Noise Source Breakdown**

- **Aerodynamic noise from train nose**
- **Noise from lower part of cars**
- **Pantograph noise**
- **Structure-borne noise**

**Graph Key**

- **FASTECH360Z + FASTECH360S**
- **FASTECH360S**
- **Series E3 + Series E2 (Commercial Train)**
- **Series E2 (Commercial Train)**

**Approximately**

- **330 km/h**
- **340 km/h**
Series E5 trains with a maximum speed of 300 km/h in March 2011 were introduced on the Tohoku Shinkansen-line. After verifying the performance of various equipment, we will increase the maximum speed to 320 km/h by March 2013.
Conclusions

1. The overall noise level of FASTECH360S at 360km/h is reduced by more than 4dB compared to that of series E2 at a speed of 360 km/h.

2. To operate at the same noise levels of current commercial trains (series E2), FASTECH360S and FASTECH360Z (coupled) would run at approximately 330 km/h, and FASTECH360S (alone) would run at approximately 340 km/h.

3. Many noise reduction measures were adopted to the new commercial Shinkansen "Series E5" which have a maximum speed 320 km/h.
...Thank you for your kind attention