Measurements and analysis of track irregularities on high speed maglev lines

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Research purposes

- Little research has been conducted on analyzing the irregularity of a high speed maglev line, and no detailed method has been proposed to characterize the irregularities, especially for the high speed maglev (TR08) line.
- In this paper, a method for measurement and processing of irregularities of the high speed maglev line is described. By using our processing method, the irregularities are calculated by air gap and magnet displacement. The characteristics and distribution of track irregularities in space wavelengths are analyzed.

Research Purposes

- Track irregularities have important effects on the stability and ride quality of maglev trains.
- Little research has been conducted on analyzing the irregularity of a high speed maglev line, and no detailed method has been proposed to characterize the irregularities, especially for the high speed maglev (TR08) line.

Research Content

- Cause of track irregularities
- Methods for testing track irregularities
- Methods for digital processing of track irregularities
- Power spectrum density analysis of track irregularities
- Fitting of the irregularity spectrum of a high speed maglev guideway

Result and Conclusions (1)

- The irregularities data processing steps were as follows: partial filtering, integration, resampling of signal, and low pass Butterworth filter.

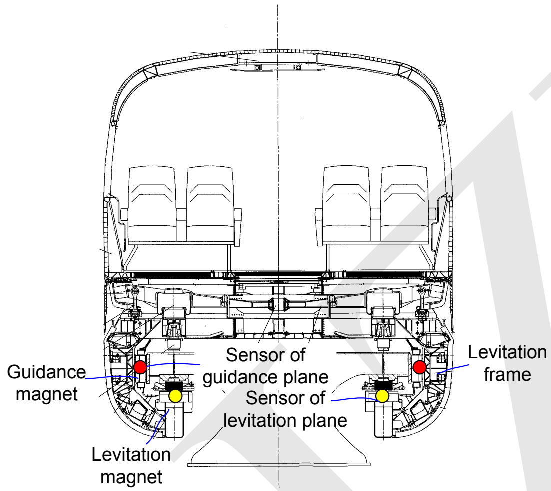


Fig. 1 Acceleration sensors installed in electromagnetic modules

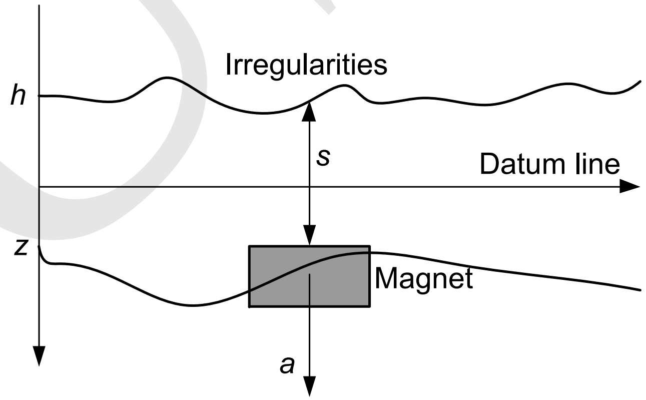
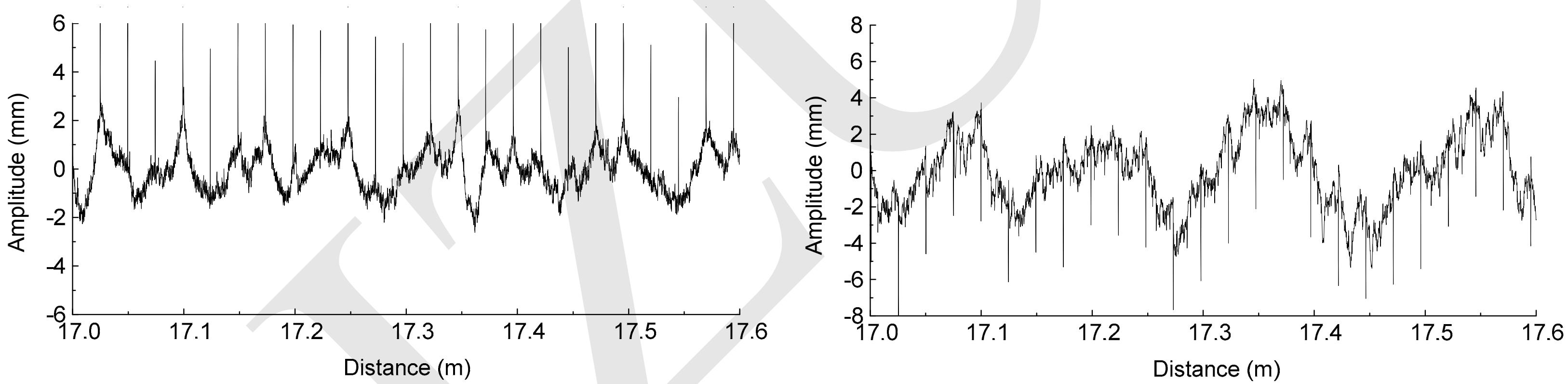


Fig.2 Principles for measuring irregularities on a high speed maglev line

Result and Conclusions (2)

- Based on the amplitudes of time domain samples, the deviation of the girder end was apparent. The maximum deviation of the stator was about 2 mm and of the guidance plane, about 4.5 mm. Irregularities of the stator plane were a little smaller than those of the guidance plane due to the high design standard of the stator.

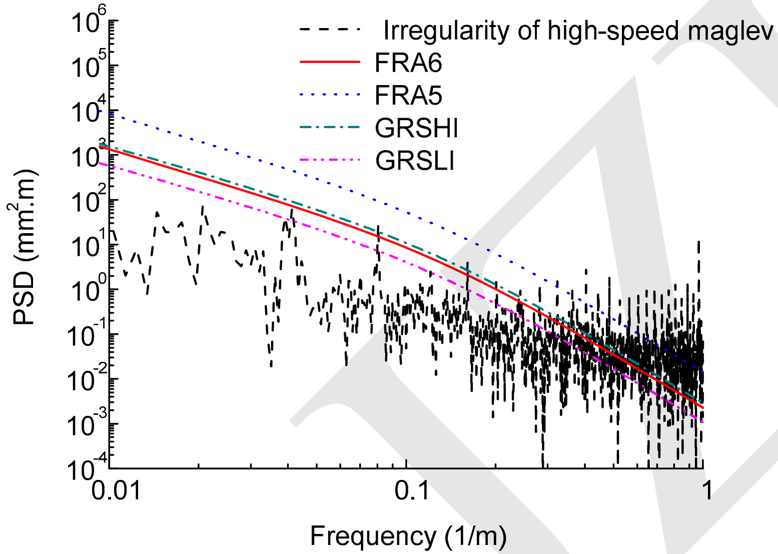


(a) Irregularities of the stator plane (b) Irregularities of guide plane

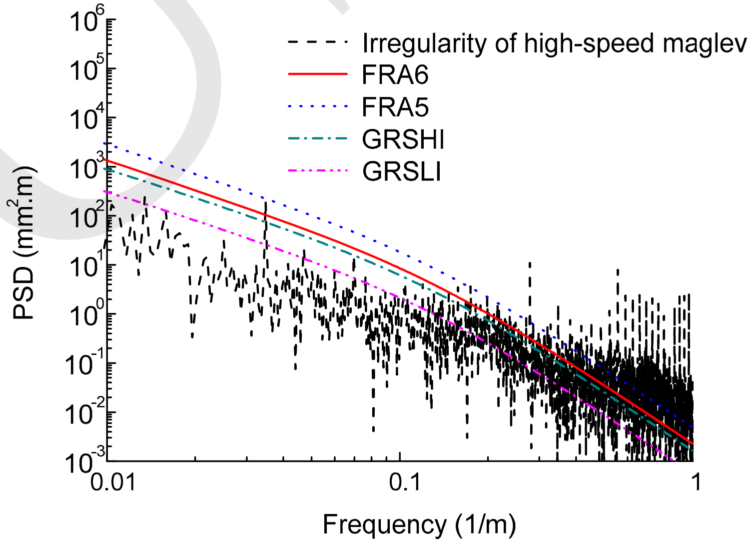
Fig. 3 Irregularities of the maglev line measured on-site

Result and Conclusions (3)

- The maglev stator plane irregularities were better than conventional railway vertical rail irregularities when the wavelength was 5–100 m, and worse when the wavelength was 1–5 m. The PSD of maglev guidance plane irregularities was similar to that of cross level GRSHL (German railway spectra of high irregularity) when the wavelength was 10–100 m. The irregularities were clearly worse than cross level rail irregularities in a conventional railway when the wavelength was 1–10 m.



(a) Comparison of the PSDs of the stator plane and railway vertical track;



(b) Comparison of the PSDs of the guidance plane and railway lateral track

Fig. 4 Power spectral density (PSD) with different irregularities

Result and Conclusions (4)

- Track irregularity data of the Shanghai high speed maglev line were collected and fitted by the least square method. The fitted PSD was clearly divided into two sections, with wavelengths of 50–100 m and 1–50 m, respectively. The fitted PSD provides a unified expression of track irregularities for high speed maglev lines.

$$S(\Omega)=\frac{A(\Omega^2+B\Omega^3+C)}{\Omega^4+D\Omega^3+E\Omega^2+F\Omega+G}$$

Table 1 Spectral characteristic parameters of PSD function

Parameter	Stator plane	Guidance plane
A	0.109 85	0.033 91
B	−2.2497 8	35.513 35
C	0.54237	−0.42813
D	−100.786 99	32.463 66
E	30.53182	1.902 77
F	−0.897 44	−0.032 11
G	0.008 69	$3.495\ 49\times10^{-5}$