Urban Acoustics

Week 3 Tutorial
Conceptual questions
Numerical questions

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Conceptual questions

1a) :

- Road traffic is the most dominant and most annoying source of environmental noise;

Conceptual questions

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- Road traffic is the most dominant and most annoying source of environmental noise;

Answer

- Wrong. Aircraft noise is the most annoying source of environmental noise. Refer Table 6.1, Page 157, Environmental noise pollution

	Percentage of Highly Annoyed				
L_{den} [dB(A)]	Road (%)	Rail (%)	Aircraft (%)	Industry (%)	Wind turbine (%)
55	6	4	27	5	26
50	4	2	18	3	13
45	1	0	12	1	6

Conceptual questions

1b) :

- The 1000 Hz frequency peak in the spectrum of road traffic noise is caused by tyre-road noise;

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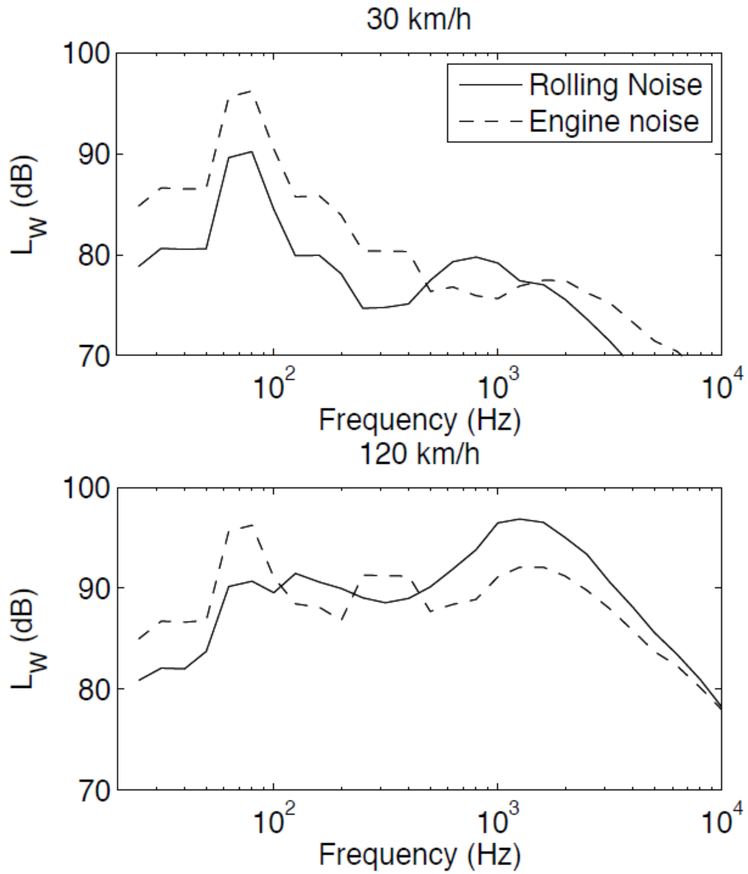
Answer

- Right.



Conceptual questions

1c) :

- Aerodynamic noise around the body of road vehicles is the second most dominant source of noise of road vehicles

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Answer

- Wrong. Rolling noise and Engine noise are the two dominant sources of noise in road vehicles.

Conceptual questions

<u>1d) :</u>

- The noise from aerodynamic sources of trains rapidly increases with the train speed

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Answer

- Right. Refer chapter 5.2.3 Environmental noise pollution.

Conceptual questions

1e) :

- Noise maps produced according to the END should include aircraft noise

Conceptual questions

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- Noise maps produced according to the END should include aircraft noise

Answer

- Right. Refer chapter 5, Environmental noise pollution.

Conceptual questions

<u>1f) :</u>

- Aircraft noise is regarded as the most annoying source of transportation noise sources

Conceptual questions

1f) :

- Aircraft noise is regarded as the most annoying source of transportation noise sources

Answer

- Right. Refer chapter 5.3, Environmental noise pollution

Conceptual questions

<u>1g) :</u>

- Noise maps have been developed for wind farms in the context of the END

Conceptual questions

1g) :

- Noise maps have been developed for wind farms in the context of the END

Answer:

- Wrong, since wind farms are relatively new. Refer to Chapter 6.5, Environmental Noise Pollution. Specific noise maps are being developed for wind farms (which e.g. better account for wind & temperature effects on sound propagation).

Conceptual questions

<u>1h) :</u>

- The problem with wind turbines is its low frequency components

Conceptual questions

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- The problem with wind turbines is its low frequency components

Answer:

- Right. People complain about low-frequency noise from wind farms, although the scientific explanation is not clear yet.

Conceptual questions

1i) :

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- At a long distance from a line source of finite length, the sound pressure level from the line source decays with 6 dB with doubling the distance to the line source

Answer:

- Right. If the line source is finite and the distance between the source and receiver is long, then the line source could be treated as a point source.

Conceptual questions

1j) :

- The sound power from a point source reduces with distance from the source.

Conceptual questions

1j) :

- The sound power from a point source reduces with distance from the source.

Answer:

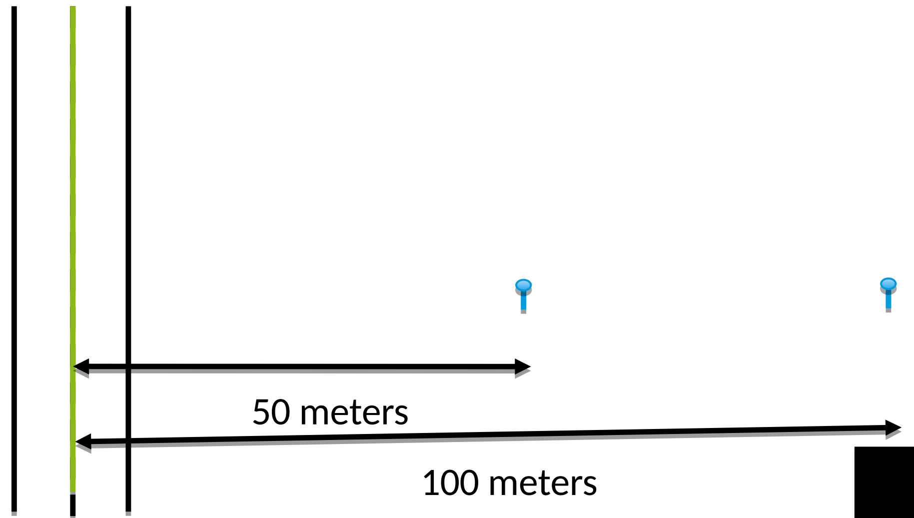
- Wrong. Sound power is not a property of the distance between the source and receiver. It describes the source in isolation, independently of propagation effects.

Exercises

2):

- Plans are made to build a residential area close to a highway. To analyse the noise level due to the highway in this area, you need to compute the noise level at a position 50 m and a position 100 m away from the highway.

a) Assume that the highway is very long and straight. The averaged sound power level from this highway has been estimated at E = 91.5 dB(A). Compute the sound pressure level in dB(A) at the two receiver points. Neglect the effect of the ground.



Exercises

Answer 2a):

- Long and straight road $\rightarrow$ line source

$$L_{p,\mathrm{road}} = E_{\mathrm{road}} - 10\log_{10}\left(2\pi r_{\mathrm{road}}\right) \quad \text{with} \quad r_{\mathrm{road}} = \{50, 100\}\ \mathrm{m}$$

- Replace:

$$L_{p,\mathrm{road}} = 91.5 - 10\log_{10}\left(2\pi\{50, 100\}\right) \approx \{66.5, 63.5\}\,\mathrm{dB(A)}$$

Here, the sound power is in dB(A), so the sound level is also in dB(A)
(i.e., don't apply the correction twice)

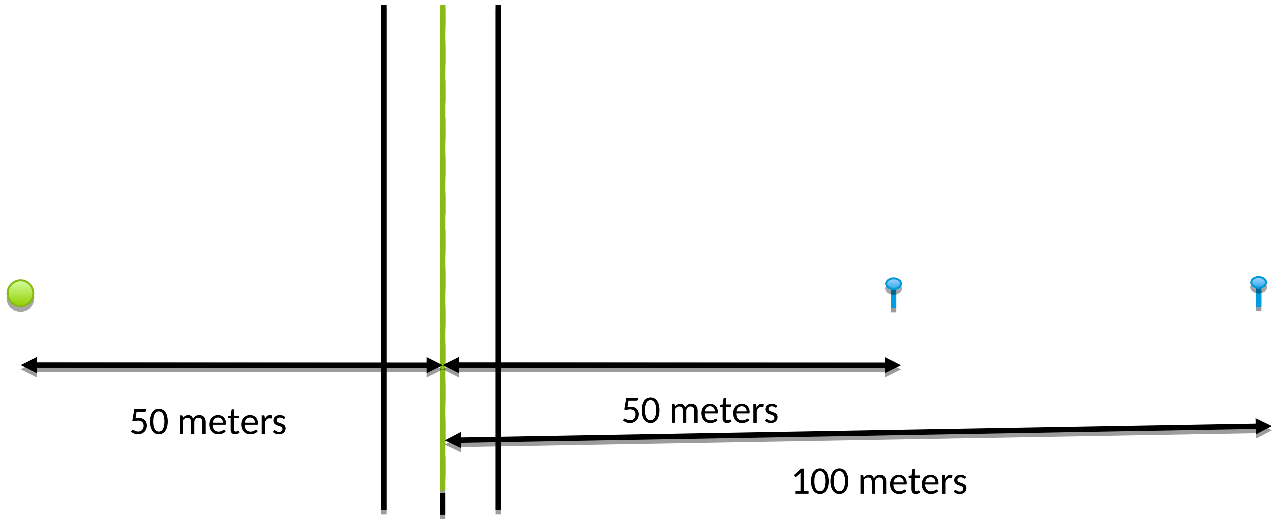
Exercises

2)b)

50 m at the other side of the road, a small industrial building is located. The building produces a high noise level and the sound power is estimated at E = 111.1 dB(A).

Compute the total noise level at the two receiver positions from the highway and the industrial building, while considering the building as a point source. Explain the sound level difference between the two receiver position compared to the answer of 2a).

Exercises



Answer 2b):

Noise from the industrial building (point source):

$$L_{p,\text{build}} = E_{\text{build}} - 10\log_{10}\left(4\pi r_{\text{build}}^2\right) \quad \text{with} \quad r_{\text{build}} = r_{\text{road}} + 50\ \text{m} = \{100{,}150\}\ \text{m}$$

$$L_{p,\text{build}} = 111.1 - 10\log_{10}\left(4\pi\{100,150\}^2\right) \approx \{60.1, 56.6\}\ \text{dB(A)}$$

Total noise from both sources (logarithmic summation):

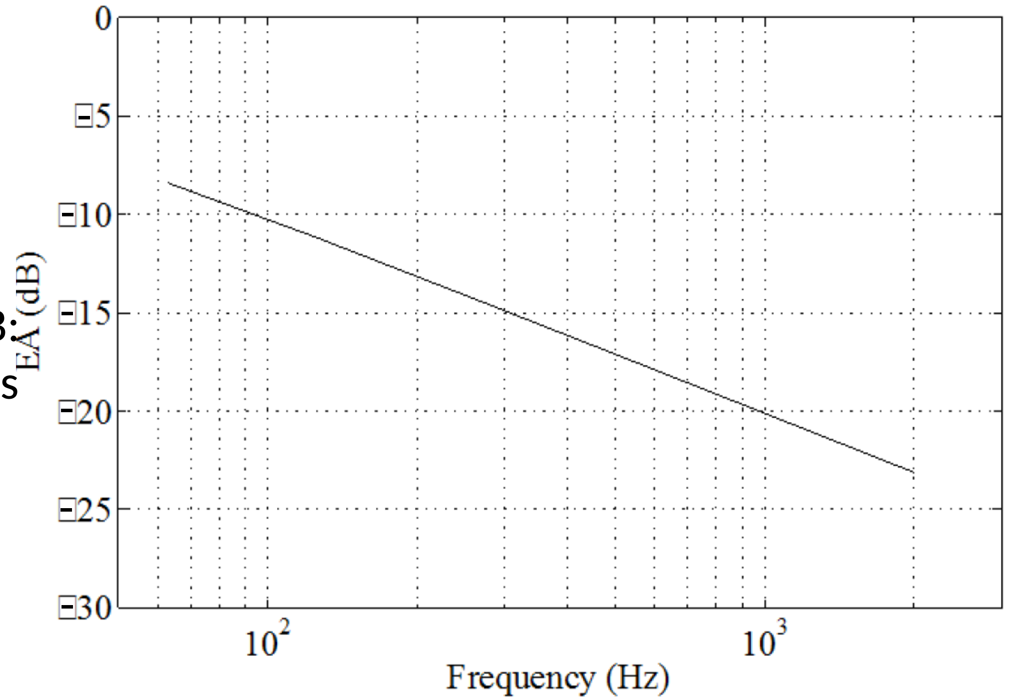
$$L_{p,\text{total}} = 10\log_{10}\left(10^{L_{p,\text{road}}/10} + 10^{L_{p,\text{build}}/10}\right) \approx \{67.4, 64.3\}\ \text{dB(A)}$$

The industrial building only adds about 1 dB(A) for both receivers to the total sound level, since the building is far away. Since its noise decreases faster with range compared to the road (because it's a point source), the noise from the road will be more dominant at long range.

Exercises

2c): To reduce the noise in the area, you have found information on the reduction of noise by a noise screen, see Figure below. To assess the potential reduction of noise by the screen for road traffic and the industrial noise source, you also have access to the power spectra of the road traffic and the industrial building, see Table below.

Spectral effect of a noise screen expressed by EA (Excess Attenuation) in dB: a negative EA value means a reduction of noise



Exercises

Answer 2c):

Spectral values of the sound power from the road and industry building.

Octave band middle frequency (Hz)	E_{road} (dB(A))	$E_{industry}$ (dB(A))
63	61	95
125	67	110
250	75	104
500	79	90
1000	88	85
2000	88	85
4000	81	83
8000	73	80

- The sound power of the road is loudest at the **high** frequencies
- The sound power of the building is loudest at the **low** frequencies
- The screen reduces noise better for the higher frequencies
- The noise from the road is louder at the receiver positions, compared to the building

→ The screen will be more effective to reduce noise from the road

Exercises

3):

Two different wind turbines are located 300m from each other. You need to calculate the distance dependent sound level in the direction of a residential area. The second wind turbine is always 300 m further away than the first turbine in this direction. You plan to measure the sound pressure level at some points and extract the sound power level from the two turbines using this data. Once you have the sound power levels, you can compute the sound pressure level at all possible distances from the turbines. How many measurements are needed in this strategy. Consider the wind turbines as point sources and neglect the ground effect for simplicity.

Exercises

Answer 3):

This is a tricky question. The sound level generated by each individual turbine (T1 and T2, considered as point sources) at position *r* is given as

$$L_{p,\mathrm{T1}}(r) = E_{\mathrm{T1}} - 10\log_{10}\left(4\pi r^2\right) \quad \text{and} \quad L_{p,\mathrm{T2}}(r) = E_{\mathrm{T2}} - 10\log_{10}\left(4\pi r^2\right)$$

The total sound level can be computed with: $L_{p,\mathrm{total}}(r) = 10\log_{10}\left(10^{\frac{L_{p,\mathrm{T1}}(r)}{10}} + 10^{\frac{L_{p,\mathrm{T2}}(r)}{10}}\right)$

By measuring at 2 locations r_1 and r_2 , you would measure $L_{p,\mathrm{total}}(r_1)$ and $L_{p,\mathrm{total}}(r_2)$

From this, by replacing the above expressions, you could in theory estimate the sound power E_{T1} and E_{T2} of the 2 turbines as the solution of a system of 2 equations and 2 unknowns.

This is however not so easy to do analytically…