Issue 5 - November 2012

CityHush

CityHush – Accoustically Green Road Vehicles and City Areas

About CityHush

The CityHush project supports city administrations with the development and implementation of noise action plans according to the directive EC 2002/49. Noise action plans made with existing technology suffer from major shortcomings: there is a poor correlation between hot spots and annoyance and complaints, most measures lead to increased emissions, and only indoor noise comfort is addressed.

In order to reduce noise in city environments, CityHush has developed suitable problem identification and evaluation tools and designed noise reduction solutions for hot spots that show a high correlation with annoyance and complaints. The innovative solutions and tools developed are listed below.

Urban planning & noise score rating systems

- Q-zones;
- parks embedded in Q-Zones;
- improved indoor noise score rating models integrating low-frequency noise and the occurrence of high noise single events;
- noise score rating models for the outdoors.

Vehicles, tyres & road surfaces

- objective and psychoacoustic evaluation tool for low noise low emission vehicles;
- mathematical synthesis tool for noise from low noise low emission vehicles;
- general performance noise specifications for low noise low emission vehicles;
- novel concepts for low noise roads based upon dense elastic road surfaces;
- novel concepts for low noise roads based upon grinding of asphalt top layers;
- novel concepts for tyres for low noise vehicles, including heavy vehicles;
- criteria for use of low noise motorcycles;
- active and passive noise attenuation measures within the tyre hood.

Building design & noise barriers

- solutions for high low-frequency absorption at facades of buildings;
- solutions for high low-frequency isolation in the propagation path.

The CityHush project is co-funded by the European Commission under the 7th Framework Programme for RTD.

Duration: January 2010 - December 2012

Budget: appr. 5 m€

13 partners in 7 countries

www.cityhush.eu

Editorial

We are happy to present you the fifth and final issue of the CityHush newsletter. This issue marks the last phase of the project, when final results have become available.

These results will also be presented at the CityHush series of events planned until the end of this year. One seminar and two training workshops are coming up.

The training workshops target local authorities and will teach participants how the tools developed by CityHush can assist them in tackling transport noise problems in their cities and meeting the European Noise Directive requirements. These tools include the concept of quiet zones, noise absorbing facades, low-noise road surfaces, and others. The first training workshop will take place within the framework of the annual Polis conference, in Perugia on 29-30 November 2012.

The seminar, which targets stakeholders from different sectors interested in urban transport noise abatement, and the second training workshop will take place on 11 December in Stockholm. They are organised in conjunction with the final seminar of the European Hosanna project (**www.greener-cities.eu**) on 10 December in Stockholm, which works towards a toolbox for the reduction of road and rail traffic noise in the outdoor environment.

To register, go to **www.cityhush.eu**.

We wish you a pleasant read and look forward to seeing you at one of our events!

In this issue...

Visitor distribution based noise score rating method for the outdoors

When evaluating noise exposure in urban parks and recreational areas, one of the obstacle that often arises is the estimation of the number of visitors to the specific park. Methods use map data of the number of dwellings or residents in direct conjunction to or in the vicinity of the park. The estimations are often coarse and in some cases, where the park is the main objective of people visiting a city, the estimations even fail.

Here, a way to solve the problem of bad estimations as well as adding another dimension to the evaluation of noise exposure in parks will be presented. The aim of this method is to eliminate the need for visitor data, make use of the distribution of visitors in the park, while also making the method useful in planning new parks.

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Input to the method

Input data for the method are based on the distribution of park visitors inside the park. Planning parks often includes defining points of interest inside the park. Planners sometimes have elaborate thoughts and ideas of how the park will be used, and sometimes the visual parameter is predominant in the planning process, generating solutions that may contradict the apparent noise exposure in the park.

Through visual study or by interviewing people with good local knowledge, the distribution of visitors can be estimated. When planning a park, the ideas of the landscape architect can be used to derive the distribution of visitors within the park.

Most parks have designated points of interest. These can be ice cream stands, fountains, sunny slopes etc. To simplify the method, visitors to the park can be distributed among the different points of interest.

The next group of data that have to be acquired are the traffic noise levels in the park. The simplest way of doing this is by calculating a noise map of the park. The noise levels should be averaged over the time when the park is used the most. For example, for a park that is closed at night, the noise level should be calculated for day and evening (7am-10pm). If a park is used only at lunch time, the noise levels, should relate to the lunch hour traffic data (12pm-1pm).

The next step is to assign the visitors to the noise levels that will dominate during their visit to the park. Instead of distributing visitors over the whole park, the points of interest now play an important role.

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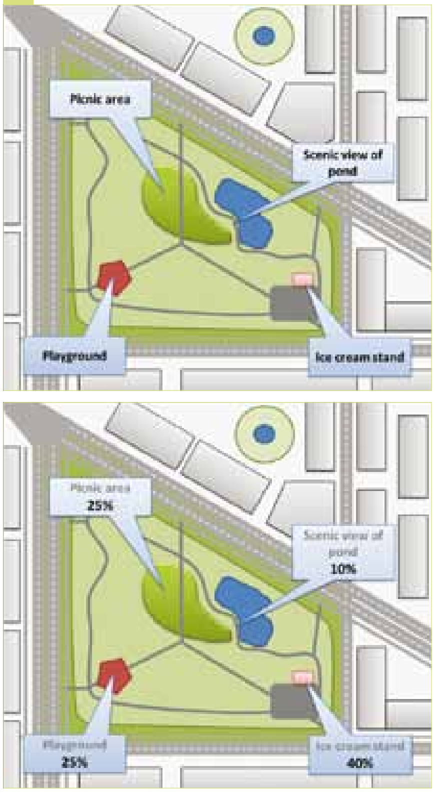

Visitors are categorised in noise classes according to their assigned value.

Using noise mapping software, the assigning process can be done automatically in 1-dB classes for improved results.

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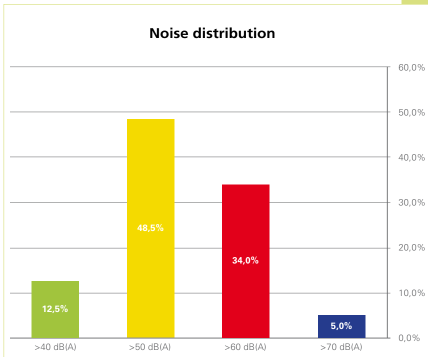

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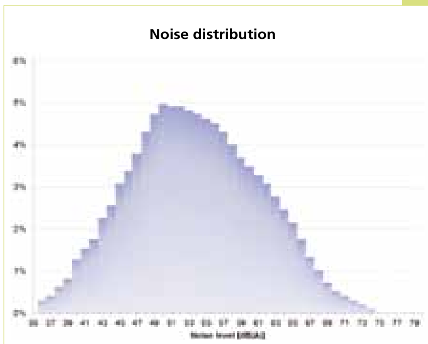

Results

In order to derive numbers of perceived sound quality in the park, different methods can be used. The curves of highly annoyed fit to be used in urban parks have been applied for the comparison studies. Here, the perceived soundscape quality curve from Mats Nilsson et al is used. The distribution of visitors per noise class is inserted in the equation and the percentage that perceived the soundscape as good or very good is derived.

The total percentage of visitors that perceived the soundscape to be good or very good amounts, in this test case, to 54%.

Measures to improve the sound quality in a park largely depend on where it is having effect. For example, a noise barrier is inserted in the noisiest north west corner of the test case park.

This part of the park has very few visitors and therefore the noise distribution is much the same as before, thus exerting no effect on the percentage that perceives the park soundscape quality as good or very good.

In order to have an effect, a local noise barrier is located near the ice cream stand. This part of the park is not the most exposed but has the highest percentage of visitors.

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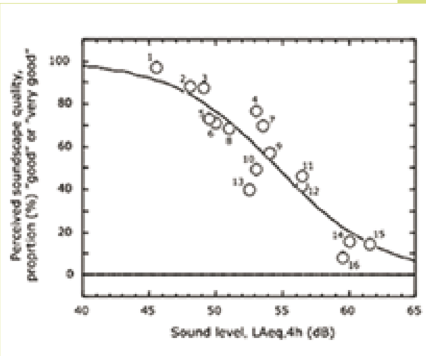

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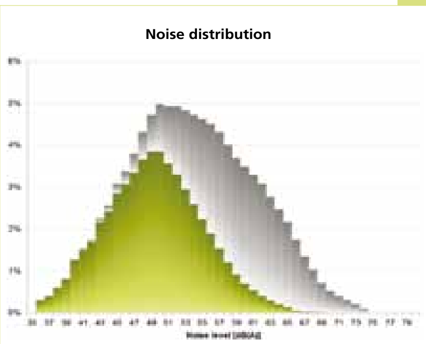

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Evaluating the park the same way as before, after introducing the local noise barrier, the percentage of park visitors that perceive the soundscape as good or very good grows to 56% total.

The method takes into account where park visitors are located in the park. This parameter makes evaluation of noise abatement measures easier. It can also be used when planning parks, taking into account the ideas and visions of the landscape architect.

In the CityHush project, a number of parks have been validated against this method. Inspection of the parks generated the need to have many different points of interest. In the end, a weighted visitor distribution of the park was used.

Author: Peter Malm, ACL

Tyre - road noise reduction by active noise attenuation

Active noise cancellation technology (ANC) as a concept is not new. The basic idea of the concept is reduction of unwanted noise by addition of a phase inverted copy of the original noise signal to the sound field. The noise level is reduced according to the superposition principle. ANC technology has been used with successful results primarily for low-frequency noise reduction in fan ducts, car- and airplane interiors. This project aims at evaluating the feasibility/possibility of active noise cancellation technology in combination with tyre hoods. Earlier performed CPX measurements have shown that the tyre hood has the potential of reducing the tyre/road noise in the range of 1 – 5 dBA-units. This project investigates the possibility of achieving an even greater noise reduction when the tyre hood is combined with an ANC system.

The main focus has been to evaluate the concept and potential of noise reduction by ANC technology in a semi-anechoic lab environment. The concept was also evaluated by simplified field measurements with the CPX (Close proximity) method.

Lab test methodology

The laboratory tests were performed in Tyréns semi-anechoic chamber in Stockholm. The chamber can be seen as an acoustic representation of a "perfect" outdoor environment, free of background noise and sound reflecting surfaces, which was ideal for our initial testing. A basic tyre hood mock-up was built and set up in the lab. The mock-up was equipped with a commercially available DSP based ANC-system (S-CubeTM Development Kit from Silentium). The tyre noise was simulated by a loudspeaker fitted inside the tyre hood and fed with the pre-recorded tyre-noise sound material. The noise signal used as sound source in the laboratory tests was recorded using the CPX method using a single wheel trailer rolling on a standard road surface with 11 mm maximum stone size. A high-quality loudspeaker was mounted in close proximity to the noise source and used as a sound cancelling source.

The combined sound field from the noise- and cancelling sources is of a reactive type with angle-dependent sound energy distribution and distance-dependent directivity, obtained sound level reduction/increase is therefore angle- and distance dependent. The sound pressure level with and without ANC was measured in different positions (at different heights, distances and angles relative the noise source) in the chamber. Different reference- and error microphone positions as well as cancellation speaker orientations were evaluated.

Results

Performed measurements show approximately 3 dBA average sound level reduction with introduction of ANC technology (with extreme values of -5,7dBA and +0,6 dBA, measurement point dependent). The performed lab tests are of course a quite crude simplification of a real life situation (absence of background- and wind-induced noise, tyre directivity pattern, etc.) but the obtained results are still considered to be quite promising.

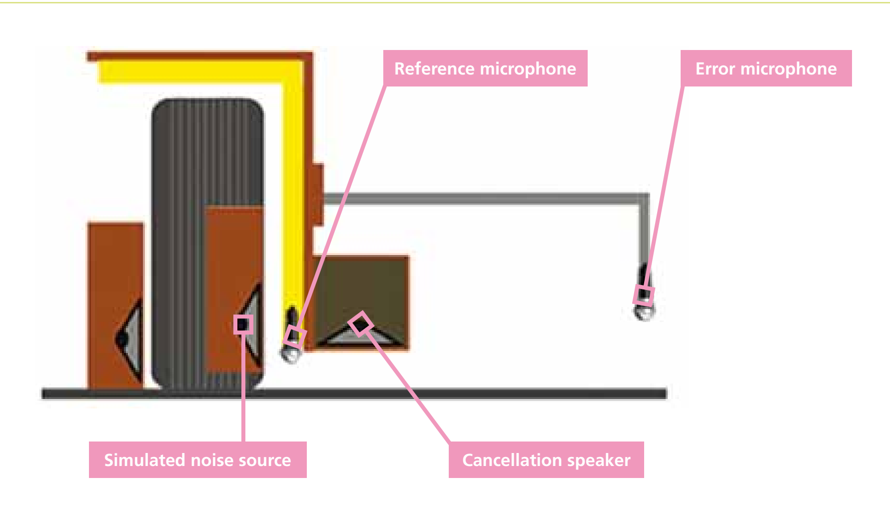

Figure 1. ANC testing setup in semi-anechoic chamber

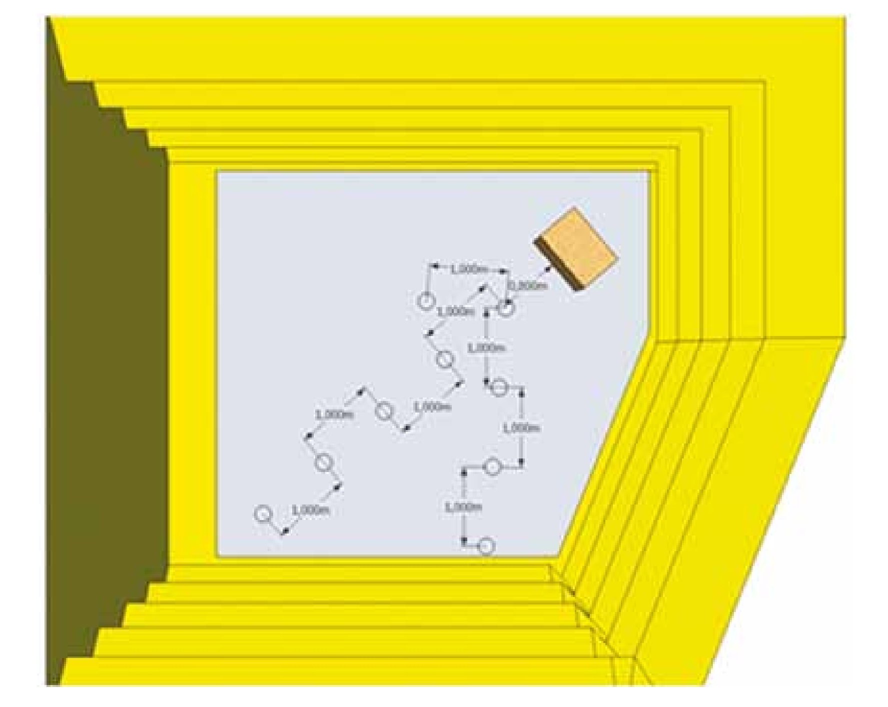

Figure 2. Measurement positions in laboratory, measurements were performed at 1 m and 2 m above the floor surface

CPX - Field tests

Some initial and simplified field tests were also performed within the project. Evaluation of the tyre-induced noise level reduction was performed with the CPX method. The tyre-hood and the ANC equipment were mounted on a CPX trailer. All tests were performed at a speed of 50 km/h on a straight road segment with the same type of road surface; the surface was slightly wet during the test. Sound pressure levels were measured six times with ANC and six times without ANC for the same road segment.

Results

The initial field tests show that it´s very difficult to attain high coherence between the reference and error microphone transfer functions. It´s assumed that the wind induced noise at the microphones is the main (but not the only reason) for a low degree of coherence. Initial measurements show very low improvement considering total A-weighted levels (approximately 1 dBA unit), though 2- 3 dB sound level reduction could be obtained in certain frequency bands at the CPX microphone position with the introduction of ANC technology.

Figure 3. The measurement equipage

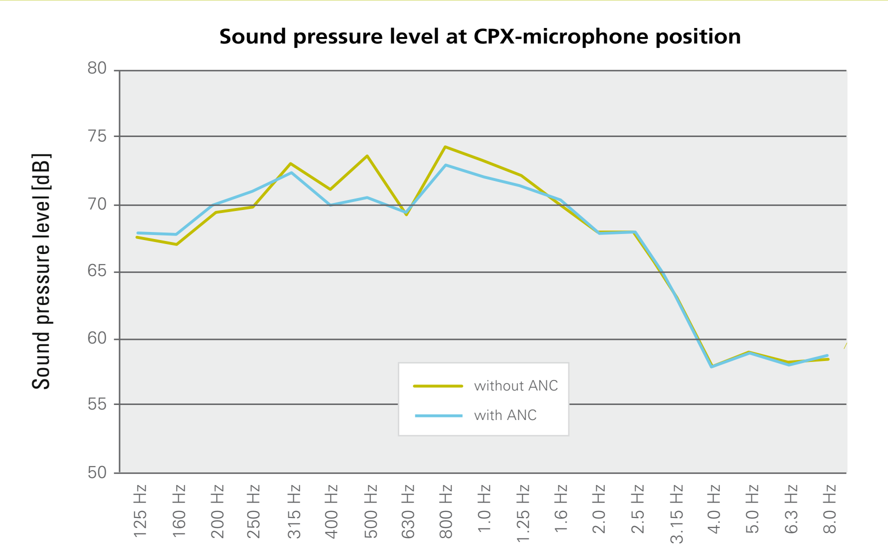

Figure 4. Plotted sound pressure level at CPX microphone position, with and without ANC

Author: Philip Zalyaletdinov, ACL

Low-noise tyres for electric vehicles

One of the components of traffic noise is generated by the interaction between motor vehicle tyres and the road surface. The amplitude and frequency content of this noise is a function of many parameters, including the road surface texture, tyre dimensions, tyre materials and construction, and the tread pattern design.

Within CityHush, engineers of the Goodyear Innovation Center Luxemburg developed a prototype tyre specifically aiming to fulfill the requirements of compact electric vehicles like Citroen C0, Peugeot iOn, Mitsubishi i-MiEV etc. The reason is that at higher speeds (above 50 km/h), electric cars are just as noisy as usual cars due to the fact that the overall noise is dominated by tyre/road noise.

The design of the concept tyre is suited to complement the performance requirements of electric vehicles. Electric engines often provide a relatively high torque, even at very low speeds, which increases the acceleration performance of an electric vehicle in comparison to a vehicle with a similar internal combustion engine. This required the development of a modified tread design in combination with a new tread compound to ensure reduced noise generation, excellent grip on wet roads and low rolling resistance. The prototype tyre was shown at the Geneva International Motor Show (see image 1).

Exterior noise generation of the tyre has been evaluated on a compact electric vehicle cruising on a smooth low-noise road surface. The noise reduction is around 3-4 dBA (speed dependent) in comparison to a conventional treaded tyre with similar dimensions (see figure 2).

Figure 1. Low noise tyre presented at Geneva Motor Show 2012

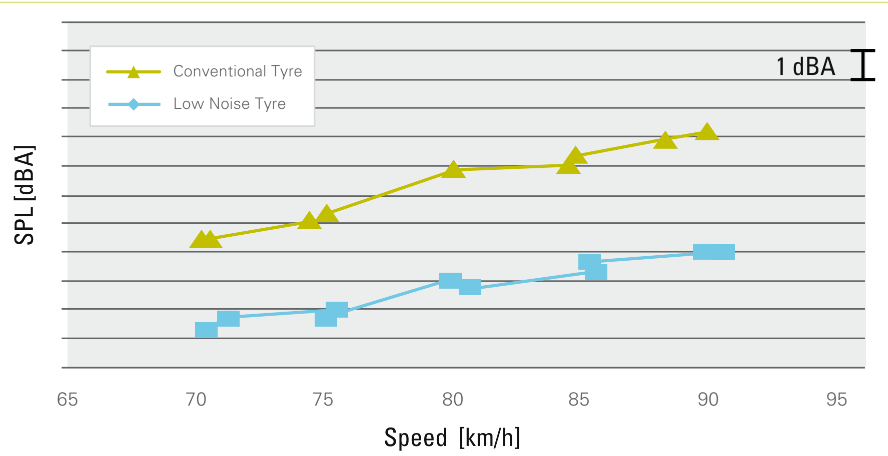

Figure 2. Exterior noise of low noise tyre versus conventional tyre

Author: Alexander Ossipov, Goodyear

Passive noise attenuation using tyre hoods

Previous studies have found tyre hoods to be an effective method for tyre/road noise reduction. Within CityHush, the concept of tyre hoods has been evaluated.

The investigation shows that the tyre hood has the potential to reduce the tyre/road noise in the range of 1 – 5 dBA-units. Further analysis shows an even larger potential in the specific frequency range between 800 Hz and 1250 Hz.

With low drive-line noise from electric driving, the tyre/road noise will dominate at speeds as low as 20 km/h. This means that for the benefit of the low electric driving noise to be fully utilised, tyre/road noise must also be reduced by 5 -10 dBA units.

The implementation of the tyre hood concept holds many complications. The initial problem of overheating needs to be solved prior to the implementation on real vehicles.

Figure 1. Modified microphone arm

The evaluation of tyre hoods was carried out using a CPX trailer. A modifiable tyre hood was developed in the early phase of the project in order to perform measurements of different tyre hood designs. The designed tyre hood was made using adjustable screens in order to shift its height relative to the road surface. Measurements were carried out to study the influence of absorption inside the tyre hood and the amount of screening required to obtain an apparent reduction of tyre/road noise. The reference tyre hood starting height over the road surface was 21 cm. The outer screen shell was extended, letting the opening between hood and road surface decrease by 2 cm at a time. These extensions were made eight times, reaching 5 cm distance between the lower hood edge and the road surface. Two additional tyre hood versions where evaluated, including absorption inside the tyre hood. The first additional tyre hood measurement with added absorption was carried out for the reference tyre hood and a second measurement on the maximum enclosed tyre hood design.

The microphone positions stated in the provisional standard CPX method (ISO CD 11819-2) had to be rearranged in order to evaluate the tyre hood effect, since the mandatory microphone positions are located too close to the tyre. The distance of the microphone was extended 0.9 m from the tyre edge, which was the limit allowed by traffic safety regulations, since measurements were carried out on a public street. The microphone was placed in the centre of the tyre.

The consequence of increasing the distance between the noise source and the receiver was a reduced signal-to-noise ratio due to wind noise and turbulence, even though a wind screen over the microphone was used.

The results only show marginal effects on the tyre road noise for the tyre hood designs with a distance between the lower hood edge and the road surface larger than 11 cm. Improved effects are displayed as the open slit between the tyre hood and the road surface reaches less than 11 cm. The results indicate that the distance of 11 cm between road surface and lower tyre hood edge acts like a breakup distance, where the tyre/road noise is rather unchanged with slits larger than 11 cm and larger reductions are first seen using slit openings smaller than 11 cm.

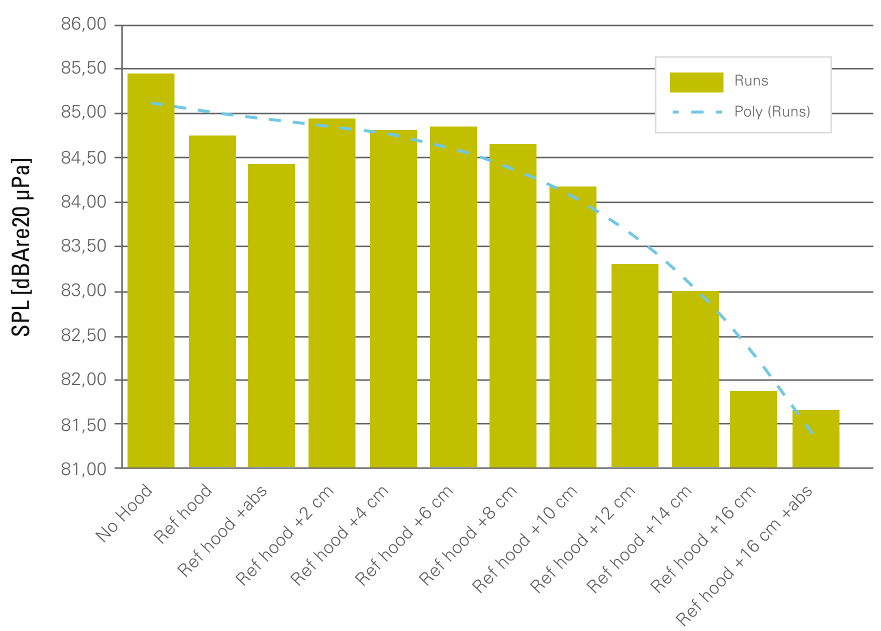

Figure 2. Total A-weighted sound pressure level for the various tyre hood designs

Author: Daniel Söderström, ACL

Invitation to the CityHush Final Expert Seminar & City Workshop
Stockholm, 11 December 2012

Now that the project is coming to an end, final results will be shared on research and recommendations regarding quiet zones, noise score rating models, low-noise vehicles, low-noise road surfaces, and noise barriers. The seminar in the morning targets urban transport noise experts from the industry, research and public sector. The workshop in the afternoon particularly addresses local authorities, to train them on how the CityHush tools can support them in developing and implementing their local transport noise abatement strategies.

Registration is free of charge and open until 2 December: **www.cityhush.eu**

Upcoming events

Date	Event	Place
29-30 November 2012	2012 Annual Polis Conference session: Acoustically green cities	Perugia, Italy
10 December 2012	Hosanna project workshop: Reduction of road and rail traffic noise	Stockholm, Sweden
11 December 2012	CityHush final expert seminar and city workshop: Reducing transport noise in cities	Stockholm, Sweden
18-21 March 2013	AIA-DAGA-EUROREGIO 2013 session: Acoustic Urban Planning	Meran, Italy

Coordinator: Martin Höjer, Tyrens (Acoustic Control AB), Martin.Hojer@tyrens.se

www.cityhush.eu

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