

CASE STUDY

Nippon Expressway Research Institute Company Limited
Reducing Environmental Road Noise, Japan

Environmental
PULSE Array Acoustics, Beamforming

Noise Scope, a PULSE-based beamforming system that includes a portable half-wheel array, was delivered to Nippon Expressway Research Institute Company Limited (NEXCO RI). This customised beamforming solution is used to measure noise in areas affected by traffic and road noise. These include residential areas, bridges, intersections, junctions, tunnels and motorway tollbooths. As a result, NEXCO-RI can optimise the design and construction of highways and their facilities to reduce the adverse effects of high-density traffic.

Photos courtesy of NEXCO



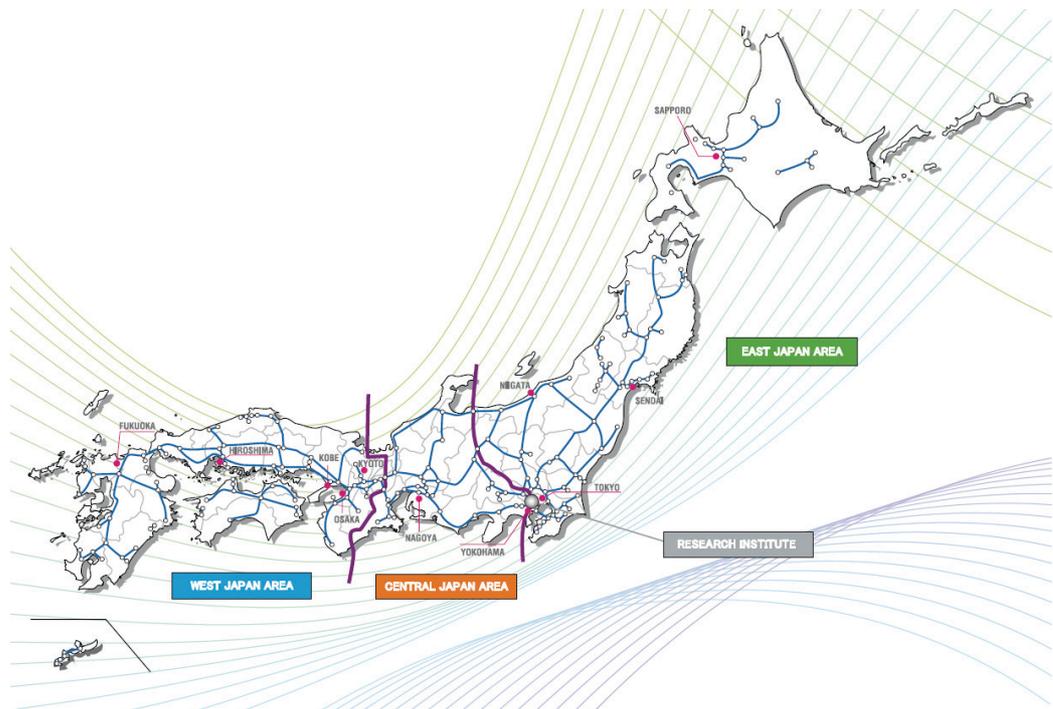
Nippon Expressway Research Institute Company Limited (NEXCO RI)

The Nippon Expressway Company Limited (NEXCO-RI) was established on 2 April, 2007 as a result of the privatisation of Japan Highway Public Corporation, which was split into the three companies on a geographical basis to better serve the Japanese people.



NEXCO RI has its headquarters and main testing facilities in Machida, Tokyo. The site includes Accelerated Corrosion Test Facilities, Accelerated Loading and Environmental Simulator, Traffic Noise Laboratory, Variable Temperature and Humidity Laboratory and a Skid Resistance Measuring Vehicle.

NEXCO RI has developed innovative and efficient solutions to be delivered to shareholders of three NEXCO companies – East Nippon Expressway Co., Ltd., Central Nippon Expressway Co., Ltd. and West Nippon Expressway Co., Ltd. NEXCO RI, which promotes advanced highway technologies intensively, works for the companies through research and development and technical support such as consultancy and advice.



Noise Reduction

From the planning and design stages to full scale operation, NEXCO RI strives to reduce traffic noise in order to fulfil environmental criteria. NEXCO-Central also works with local municipalities, police departments, automotive manufacturers, roadway administrators and drivers to lessen traffic noise. Sound insulation walls and porous asphalt pavement are two of the solutions used by NEXCO-Central to combat and reduce road and traffic noise.

Sound Insulation Walls

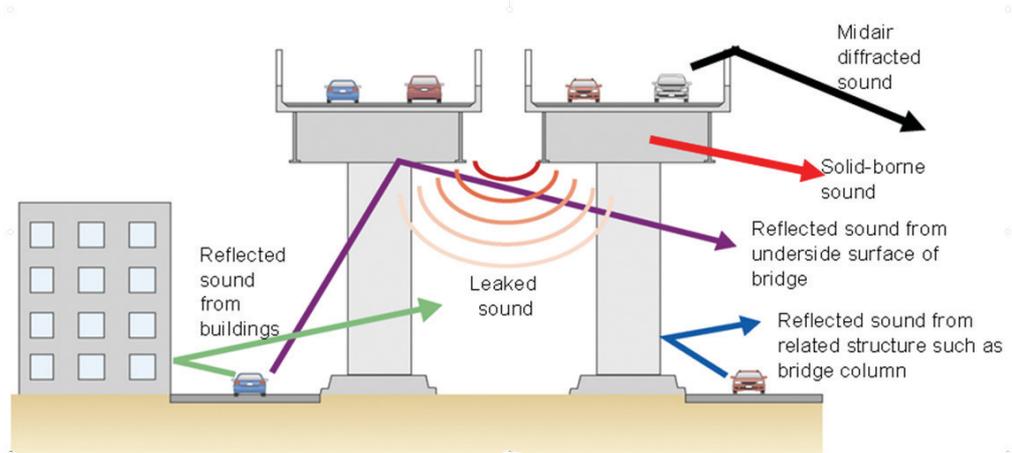
NEXCO-Central plans and installs sound insulation walls based on estimated noise levels and at the request of regional public organisations. In accordance with its five-year plan from 2009 to 2013 (fiscal year), NEXCO-Central will install sound insulation walls along more than 6 km of expressway, bringing the total to about 900 km, and raise the walls along several kilometres. In residential locations along the road, NEXCO-Central will establish environmental zones to create a favourable residential environment. NEXCO-Central also works to reduce noise by the roadside in critical situations where traffic noise exceeds environmental criteria, despite the implementation of roadside noise reduction measures.

Porous Asphalt Pavement

NEXCO-Central use porous asphalt pavement that improves road surfaces and decreases traffic noise by 2 – 4 dB, compared with conventional pavement. From 2009 to 2013 (fiscal year), NEXCO-Central plans to lay 649 km of high-performance pavement on 87% of current expressway lanes.



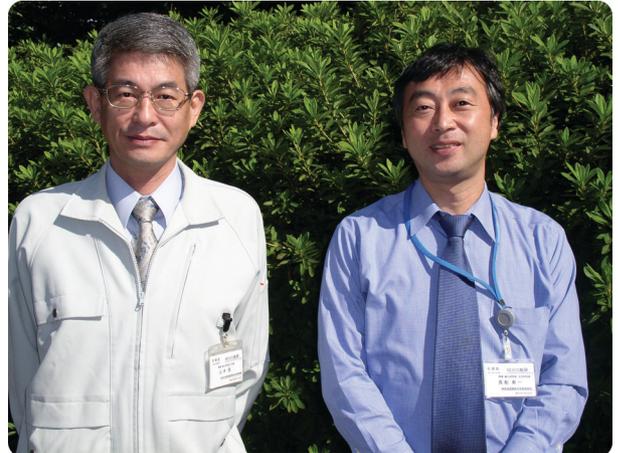
Several kinds of sound sources around an elevated bridge for expressway



Noise Scope Beamforming System

Mr. Toshikazu Osafune, Acting Division Chief, Traffic and Environmental Research Department (right), and Mr. Minoru Yamamoto, Technical Laboratory Manager at NEXCO RI (left)

To measure noise, NEXCO RI uses Noise Scope, a Brüel & Kjær beamforming system and which is an integral part of NEXCO's aim to reduce environmental road noise. It consists of a customised 3 m diameter, 42-channel, seven-armed array with each arm measuring 1.5 m in length, and a 48-channel PULSE IDA^e frame. Mr. Toshikazu Osafune, Acting Division Chief, Traffic and Environmental Research Department, says, "As traffic density cannot be reduced, we need to find solutions to reduce noise at barriers, bridges and intersections. This is where Noise Scope comes in".



Noise Scope can be positioned from three to around one hundred metres away from the noise source. "One of the great benefits of Noise Scope is that it takes less than one hour to set up at the various locations," says Mr. Minoru Yamamoto, Technical Laboratory Manager at NEXCO RI. He continues, "Noise Scope allows us to see the noise sources and levels. This, in turn, enables us to optimise the design and construction of highways and their facilities to reduce the adverse effects of high-density traffic in residential areas. We check noise levels before, for example, a barrier is installed and we follow up later to check the beneficial effects of our chosen solutions".

Noise Scope's 42-channel, 3 m in diameter microphone array



Mr. Osafune describes how Noise Scope is used, "We generally spend a day making measurements. Low wind speeds are not a problem but strong winds can affect the results and we don't use Noise Scope in the rain". He adds, "We measure over a frequency range between 300 Hz and 2 kHz. Within this range, the resolution of Noise Scope is excellent, even at distances of up to one hundred metres. We expect Brüel & Kjær to continue development so that we can measure down to 100 Hz in the future. This is our aim and future goal. One great feature of the system is the ability to take a quick look in real-time to evaluate the overall noise levels and to check system integration and correct working". He remarks, "The volume of

one day's data contains so much information that it can represent between one and two weeks of post-processing."

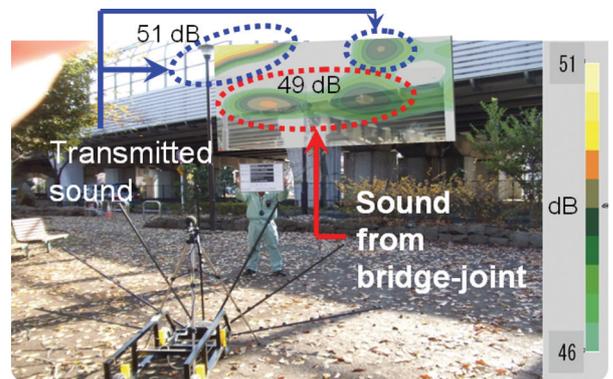
Noise Scope focuses on environmental noise only and is not used for structure-borne or vibration impact on bridges, etc. "We typically set up the array in the vicinity of bridges, junctions, toll areas and residential areas known for high-density traffic," says Mr. Yamamoto, "and we're especially interested in sound reflection off larger solid structures. We currently measure at about 10 different sites a year but this is fast-increasing."

Noise source location analysis of bridge joint. after a sound isolation panel was installed to the openings between floor slab, main girder and bridge columns to cover sound leak – the result is a 4 dB reduction of noise

1/3 octave Center frequency	Before countermeasure for burst noise	After countermeasure for burst noise
315 Hz	<p>Joint noise: 63 dB</p>	<p>Joint noise: 56 dB</p>
1000 Hz	<p>Joint noise: 53 dB</p>	<p>Joint noise: 49 dB Leaked noise</p>

Results after countermeasure installed. The results of the SPL contour mapping is overlaid on a wide view digital picture of another measurement point on the same bridge

Although Noise Scope is owned by NEXCO RI, it is also used by NEXCO-Central and the East Nippon Expressway Company and West Nippon Expressway Company. Mr. Osafune explains, "Although the system is accessible to each highway company, it has proved so popular that we have now purchased a second system for R&D purposes. In addition, each of the three companies will invest in its own system".



NEXCO RI chose Brüel & Kjær because of its reputation and its product and data quality. Mr. Osafune describes a couple of the system's most appealing features, "The resolution is excellent compared to that of competitor products and we were especially impressed with the fact that the Brüel & Kjær system could provide numerical data for contour mapping, from which it might be possible to calculate an estimation of the effectiveness of noise reduction countermeasures".

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In line with its future plans, NEXCO RI is seeking overseas opportunities where the Noise Scope system could be of great value; NEXCO RI is currently working in India.

Mr. Osafune says, "An important part of the decision to buy from Brüel & Kjær was that there is a future growth and upgrade path for us to, together, create an even more sophisticated and customised solution. There is a camera in the array, and we currently measure one minute of data synchronised to a movie. Our future goal is to increase this to eight minutes". He concludes, "We are really satisfied with Noise Scope and it entirely fulfils our expectations. I would also like to add that the local support from Brüel & Kjær Japan is outstanding".

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