Projectreport

A light earthquake-resistant construction with high sound insulation, sound absorption and fire resistance.

Nitrogen plant Gasunie Nederland
Due to a large number of earthquakes in the gas extraction area in the province of Groningen, the Dutch government has decided that gas extraction in this area must go to zero as soon as possible (mid-2022). In the longer term (2050), the ambition of the Dutch government is to disconnect all homes in the Netherlands from natural gas. Currently, more than 90% of homes are heated with natural gas. In addition to a large reinforcement operation of approximately 5,000 wins in the province of Groningen, a solution must be found in the short term for no longer being able to extract Groningen gas. The Netherlands will have to import gas from abroad for this. The problem here is that this gas is high calorific and the Dutch network and equipment is suitable for low-calorific gas.

By mixing nitrogen with (imported) high-calorific gas, pseudo Groningen gas can be produced that is suitable for the central heating and cooking equipment in households. For this, the expansion of the nitrogen installation near Zuidbroek (figure 1) is a necessary measure. As a result of the expansion, a reduction of approximately 7 billion m3 of Groningen gas per year can be achieved. This is more than 25% of the domestic consumption of low-calorific gas in 2017. The installation covers an area of approximately 12 hectares and will have a capacity of 180,000 m3 of nitrogen per hour. This capacity is more than 10 times larger than the existing nitrogen installation in Zuidbroek. The installation is scheduled to be commissioned in the third quarter of 2022.

A large hall with a length of about 150 meters, a width of 35 meters and a height of 20 meters (figure 2) will be built on the site. The entire building is divided into 8 large rooms, each room will have a large turbine. The design and engineering of this building was carried out by Air Products.

The client Gasunie has set high standards for the building. Since the building will be located in the earthquake area, a light steel construction has been chosen that can absorb any vibrations. In addition, Gasunie places high demands on the rooms where the turbines will be placed in terms of the reverberation time of the room and the sound insulation between the rooms. A question that seems contradictory and where a complex construction seems obvious. The separation structure must have a fire resistance of at least 60 minutes.

Reverberation Time
The reverberation time of the turbine space must have a value that does not exceed 0.7 seconds on average over the octave bands from 125 Hz to 2000 Hz. Since the floor is made of concrete, the absorption must be achieved through the wall and ceiling. This results in a requirement for the walls of an absorption coefficient of 0.5 for the 125 Hz octave band and 0.7 for the octave bands of 250 Hz and higher. An acoustic sandwich panel from Metecno more than meets these values (figure 3). Since these panels can also be made with two-sided perforation, this could have been a practical solution for the construction between the two turbine halls. There is also a requirement for the air sound insulation. A solution with a double-sided perforated panel is therefore not an option here because the airborne sound insulation of

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such a panel is negligible.

Airborne Sound Insulation

The requirement for the airborne sound insulation of the separation structure is a laboratory value Rw of at least 50 dB. This is a value that is not achievable with a single acoustic panel. After theoretical research combined with previous measurement results, Metecno proposed to assume an acoustic sandwich panel on two sides of a HEA 360 column.

With the help of the software program Stiff, a calculation can be made of the sound insulation of a structure. Figure 4 shows the calculated and measured value of a construction with two acoustic sandwich panels on a 96 mm cavity. The perforation of the acoustic sandwich panel is located on the outside of the construction so that the desired reverberation time is realized. Based on this result, the dimensions of the HEA360 columns and the set requirement for the fire resistance, a proposal has been developed that meets all the requirements. The proposed construction consists of two 120 mm thick acoustic stone wool panels (Hipertec Wall Sound) on a 360 mm cavity.

The client Gasunie required a measurement in the laboratory including the HEA beam. To demonstrate that the proposed construction complies with the Rw of 50 dB, Metecno carried out a large number of measurements in the laboratory of Eindhoven University of Technology. Values were obtained from an Rw 35 dB for some acoustic panels (Hipertec Wand Sound) to an Rw of 70 dB for a composite construction.

The construction as proposed could not be measured one-on-one in the laboratory, given the limit to the depth of the measuring aperture. Due to the fire resistance, the project requires an acoustic sandwich panel of 120 mm. The air cavity between the two sandwich panels is executed in the measurement with a depth of 280 mm (figure 5). The theory of a mass spring mass construction and the measurements in the laboratory show that a widening of the cavity gives an increase in the airborne sound insulation.

The measurement is carried out with and without HEA beam in the middle of the construction. The Rw value of the structure without HEA beam is 56 dB. After mounting a HEA280 beam, the Rw value is 54 dB (figure 6). In the final version, an additional mineral wool is placed in the cavity. Other measurements by Metecno show that the Rw value improves by 9 dB.

Fire resistance

For the fire resistance, a requirement of EI 60 minutes is set. The consultancy firm Peutz has drawn up an Expert judgement based on a number of measurements on a number of panels. They made a calculation of the critical steel temperature when using two panels on either side of the HEA360 column. Based on previous test results of Metecno Hipertec Wall panels and Hipertec Wall Sound panels, the following maximum temperature showed on the unheated side.

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Overview results panels with a thickness of 120 mm

Orientation (hor/ver)	Perforated (yes/no)	Integrity (minutes)	Insulation (minutes)	Maximum temperature unexposed side	Maximum span (m)
vertical	yes	60	60	159 °C after 60 minutes	3
vertical	no	90	80	253 °C after 90 minutes	6,8
horizontal	no	120	120	151 °C after 120 minutes	5
horizontal	no	90	80	237 °C after 90 minutes	6 + 2

The conclusion based on Peutz research is that the fire resistance of at least 60 minutes on the criteria of flame and temperature are achieved. In addition, the critical steel temperature of 550°C will be amply not achieved. The steel structure did not have to be treated separately with a fire-resistant coating for this project. For this project, this meant a cost saving of more than 700k€.

Conclusion

If a wall construction has to be sound-absorbing and sound-insulating, in many cases a composite construction is built where part of the construction is intended for absorption and another part for insulation. These are often expensive constructions due to a complex of materials and more labor.

By using acoustic sandwich panels, both parameters can be realized by a much simpler construction. This results in a significant reduction in material and labor costs. For more information or insight into Metecno measurements, please contact sound@metecno.de.

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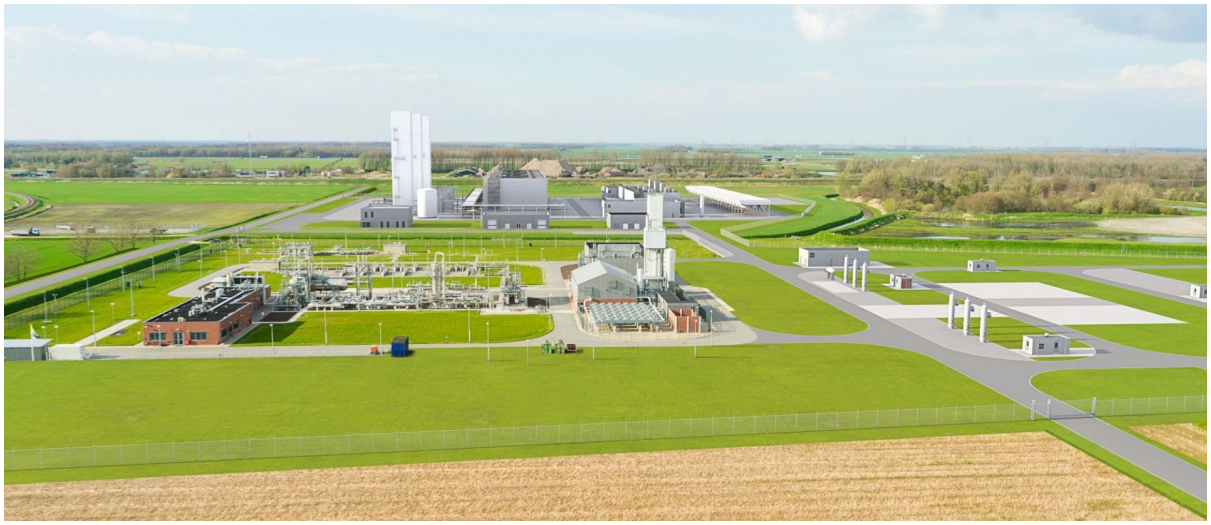

Overview of the Gasunie nitrogen plant in Zuidbroek.

Photo of the construction of the Gasunie nitrogen plant in Zuidbroek.

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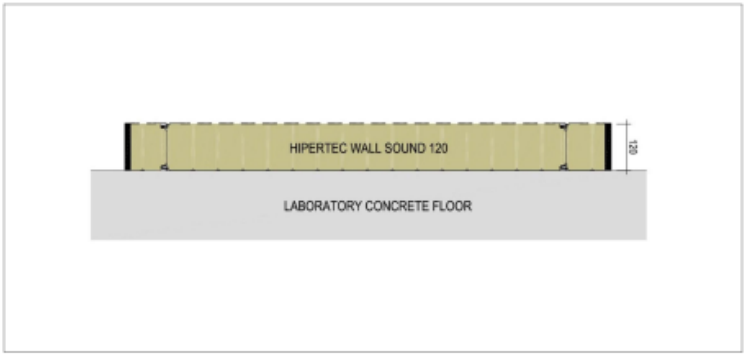
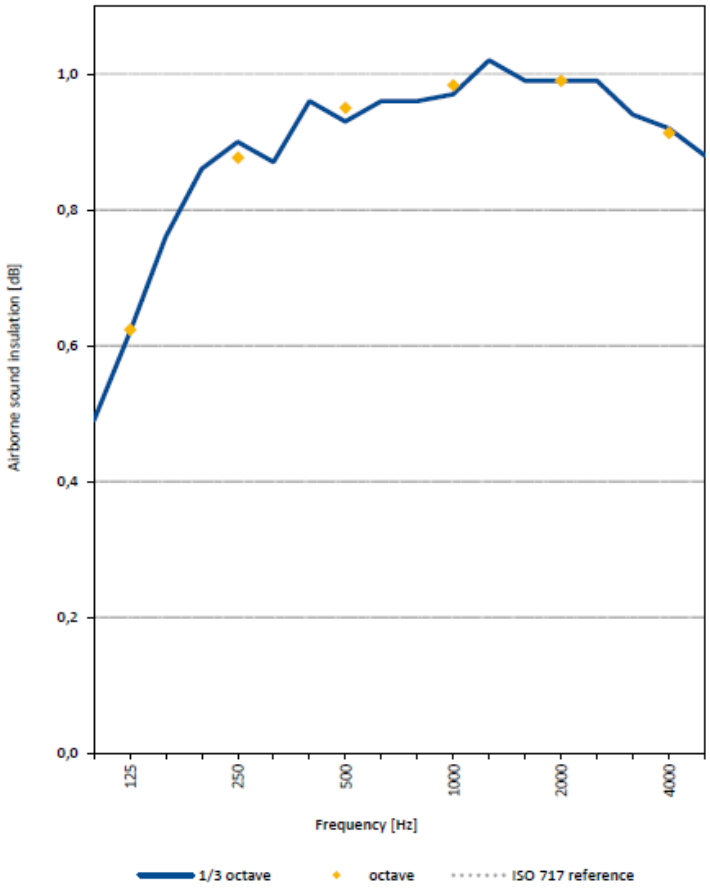
Measurement of the sound absorption

System
Hipertec Wall Sound 120 mm



Surface	15,1	m^2
Thickness	120	mm
Standard	ISO354:1993	

Freq. [Hz]	α ⅓ oct.	α oct.
125	0,49 0,62 0,76	0,62
250	0,86 0,90 0,87	0,88
500	0,96 0,93 0,96	0,95
1000	0,96 0,97 1,02	0,98
2000	0,99 0,99 0,99	0,99
4000	0,94 0,92 0,88	0,91



α_w	1,00
NRC	-

Country	Germany
Laboratory	Fraunhofer
Report nr.	031
Test year	2003

The measured value of the absorption coefficient of the Hipertec Wall Sound 120 mm.

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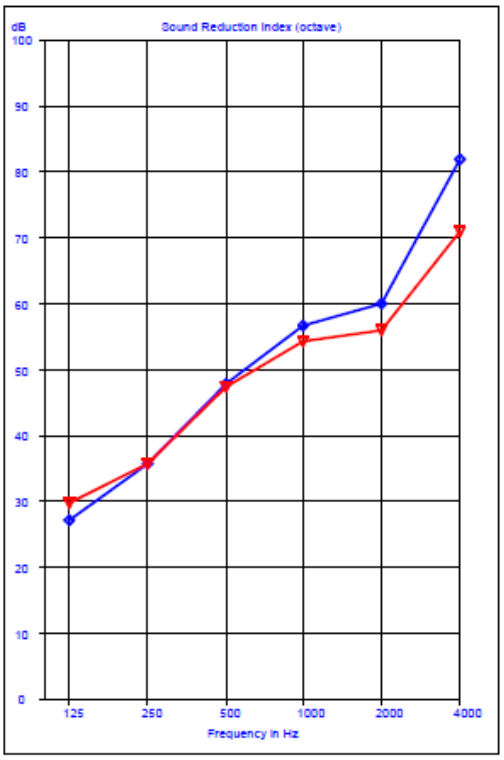
Gasunie Groningen (comparison calculation/measurement)

AcouS
STIFF-19.73n
Gasunie



Results

ISO 717 : Rw/dRw(C;Ctr;C50-3150;Ctr50-3150;....) dB

Title	Style	100-3150 Hz
M HWS 100mm - cavity 96mm - HWS 100mm	TR	48 (-3;-8)
C HWS 100mm - cavity 96 mm - HWS 100mm	R	48 (-2;-6)

Results in octave band (Central frequency in Hz)

Title	Style	31.5	63	125	250	500	1000	2000	4000	8000
M HWS 100mm - cavity 96mm - HWS 100m	TR		18	27	36	48	57	60	82	
C HWS 100mm - cavity 96 mm - HWS 100n	R	19	34	30	36	47	54	56	71	80

In this graph a comparison is made between a value (C) calculated with STIFF and a measured value (M). The construction is a cavity of 96 mm with a Hipertec Wall Sound 100 mm on both sides.

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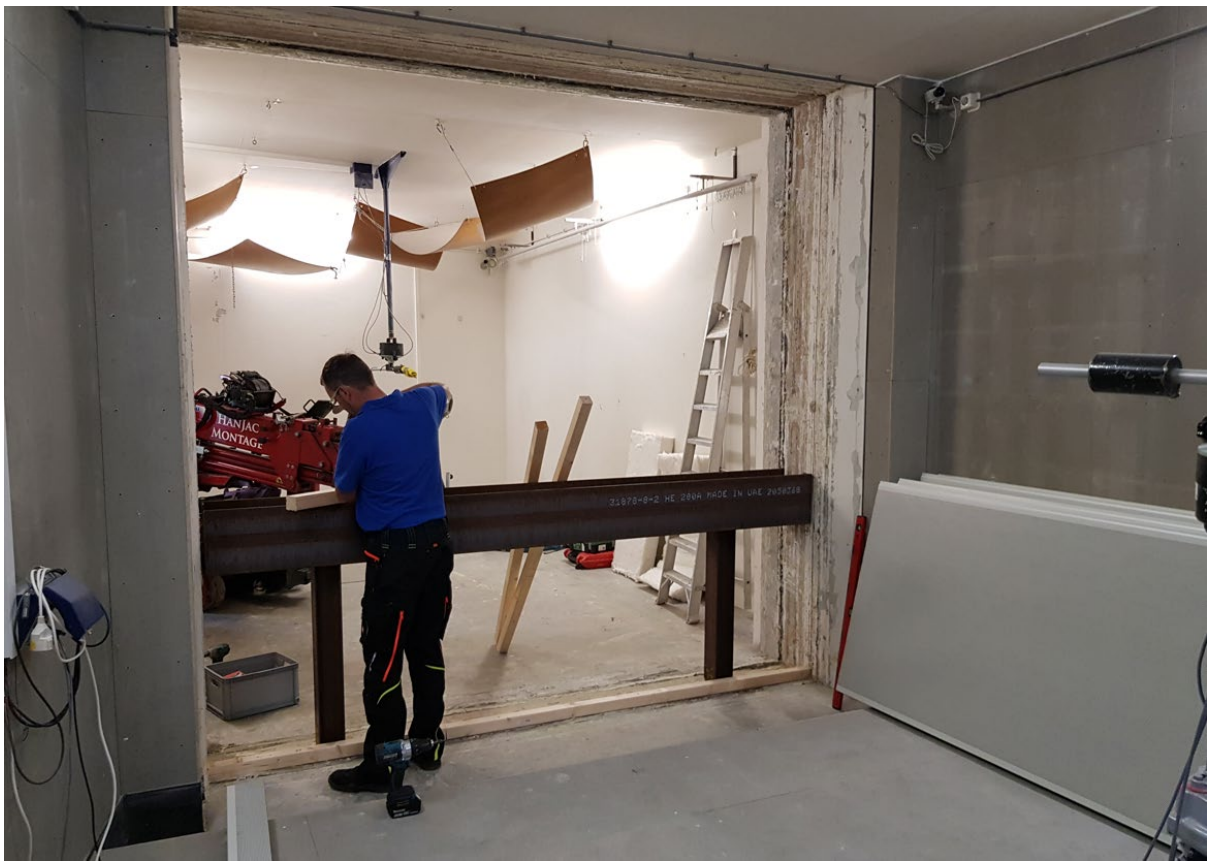

Mounting HEA beam in acoustic laboratory.

Due to the dimensions of the laboratory, a HEA 280 beam was chosen. This is on two smaller HEA columns that are on the decoupled part between the two measuring rooms.

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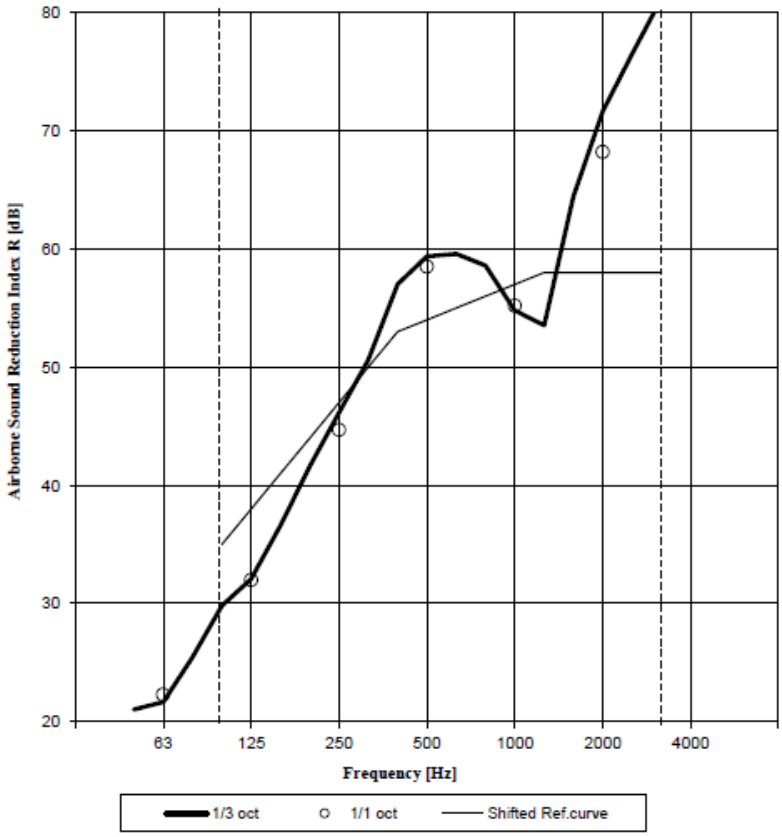
AIRBORNE SOUND REDUCTION INDEX IN ACCORDANCE WITH ISO 10140-2
Acoustics Laboratory: Level Acoustics & Vibration

Client	:	Metecno GmbH	Mass	: 43.8	kg/m²
		Am Amselberg 1	Area S	: 10.0	m²
		99444 Blankenhain Deutschland	Receiving room volume	: 82	m³
Projectnumber	:	LA.200601	Air Temperature	: 21.0	°C
Test Date	:	7-9-2020	Relative Humidity	: 50.0	%

Object description: **2x Hipertec Wall Sound 120 - Air cavity 280 mm - Steel beam HEA280 halfway (screwed)**
nr. 29
Wooden frame one side each panel - silicone seal one side
Edge filled with rock wool
perforation facing outwards
Steel beam HEA280 in cavity (screwed to panels)

Freq.	R	
	1/3 oct	1/1 oct
Hz	dB	dB
50	21.0	
63	21.7	22.3
80	25.5	
100	29.8	
125	32.1	32.0
160	36.6	
200	41.6	
250	46.1	44.7
315	50.6	
400	57.0	
500	59.4	58.5
630	59.6	
800	58.6	
1000	54.8	55.2
1250	53.5	
1600	64.4	
2000	71.6	68.2
2500	76.5	
3150	81.1	
4000	84.9	82.7
5000	83.0	



--- (ISO 717-1 range)
SNR < 6 dB

Rating in accordance with NEN-EN-ISO 717-1

$R_w(C;C_{tr}) = 54(-2,-8)$ dB

$(C_{50\text{-}3150};C_{tr\ 50\text{-}3150}) = (-4,-14)$
$(C_{50\text{-}5000};C_{tr\ 50\text{-}5000}) = (-3,-14)$
$(C_{100\text{-}5000};C_{tr\ 100\text{-}5000}) = (-1,-8)$

Measurement result of the construction with a Hipertec Wall Sound 120 mm on both sides with a HEA bar in the cavity of 280 mm. The panels are mechanically attached to the column. The perforation of the panels is towards the measuring room.

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