Fraunhofer Institut Bauphysik

Bauaufsichtlich anerkannte Stelle
für Prüfung, Überwachung und
Zertifizierung
Zulassung neuer Baustoffe, Bauteile
und Bauarten
Forschung, Entwicklung,
Demonstration und Beratung auf
den Gebieten der Bauphysik

Institutsleitung
Univ.-Prof. Dr. Gerd Hauser
Univ.-Prof. Dr. Klaus Sedlbauer

Test report P-BA 253/2007e

Determination of the Acoustic Performance of a Wastewater Installation System in the Laboratory

Client: FRIATEC AG
Division Gebäudetechnik
Postfach 71 02 61
68222 Mannheim
GERMANY

Test specimen: "FRIAPHON M1" wastewater installation (manufacturer: FRIATEC AG)

Contents:

The tests were performed in a laboratory accredited by the German Accreditation System for Testing (DAP, file no. PL-3743.26) according to standard EN ISO/IEC 17025.

Stuttgart, November 26, 2008

Responsible Test Engineer: Head of Laboratory:

Dipl.-Ing.(FH) J. Mohr Dr. rer. nat. L. Weber

FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG e.V. 1
Fraunhofer Institut Bauphysik
amtlich anerkannte Prüfstelle

Fraunhofer-Institut für Bauphysik
Nobelstraße 12 · D-70569 Stuttgart
Telefon +49 (0) 711/970-00
Telefax +49 (0) 711/970-3395
www.ibp.fraunhofer.de

Institutsteil Holzkirchen
Fraunhoferstr. 10 · D-83626 Valley
Telefon +49 (0) 8024/643-0
Telefax +49 (0) 8024/643-66
www.bauphysik.de

Projektgruppe Kassel
Gottschalkstr. 28a · D-34127 Kassel
Telefon +49 (0) 561/804-1870
Telefax +49 (0) 561/804-3187

Determination of the installation sound level L_{In} in the laboratory

P-BA 253/2007e

Table 1

Client: FRIATEC AG, Division Gebäudetechnik, Postfach 71 02 61, 68222 Mannheim

Test specimen: "FRIAPHON M1" wastewater installation system (test specimen S 9918-04) manufacturer: FRIATEC AG.

Test set-up:
- The pipe system was mounted according to Figure 4 (see also Annex A).
- "FRIAPHON M1" wastewater system : Straight pipes (nominal size OD 110) with two layer wall construction: inner layer made of PVC-U/PVC-C, outer layer made of mineral reinforced PVC-U/PVC-C. Total wall thickness 5.3 mm, density 1.55 g/cm³, weight 2.86 kg/m. One-layer fittings, size OD 110, made of PVC_U/PVC-C , wall thickness 5.3 mm, density 1.44 g/cm³. Connection of the pipes by plug-on socket connection. (Values are manufacturer's information.)
- Related fixing system: "FRIAPHON supporting clamp" and standard pipe clamps (loose clamps) with elastomer inlay. In every storey (UG and EG) two pipe clamps were installed: below a supporting clamp (two parts) fixed to the installation wall with a fastening plate and with dowels and thread rods and above a loose clamp fixed with dowels and thread rods.

The wastewater system consisted of straight pipes (OD 110), three inlet tees, two 45°-basement bends and a horizontal drain section. The inlet tees in the basement and in the ground floor were closed by lids supplied by the manufacturer. Connection of the pipes by plug-on socket connection The pipe system was mounted by a technical firm.

Test facility: Installation test facility P12, mass per unit area of the installation wall: 220 kg/m², installation rooms: sub-basement (KG), basement (UG) front, ground floor (EG) front and top floor (DG), measuring rooms: UG front, UG rear (details in Annex P and EN 14366: 2005-02).

Test method: The measurements were performed following EN 14366 and German standard DIN 52 219: 1993-07; noise excitation by permanent water flow with 0.5 l/s, 1.0 l/s, 2.0 l/s and 4.0 l/s (details in Annexes A and F).

Results:

"FRIAPHON M1" waste water system with "FRIAPHON supporting clamps"				
Flow rate [l/s]	0,5	1,0	2,0	4,0
Installation sound level L_{In} [dB(A)] measured in the basement test-room UG front	45	48	50	53
Installation sound level L_{In} [dB(A)] measured in the basement test-room UG rear	6	10	14	19
Installation sound level L_{In} [dB(A)] measured in the basement test-room UG rear **without** pipe clamps	2	5	7	12
Airborne sound pressure level $L_{a,A}$ [dB(A)] [1]	45	48	50	52
Structure-borne sound characteristic level $L_{sc,A}$ [dB(A)] [1]	3	7	12	17

[1] Evaluation according to EN 14366.

Date of tests: September 4, 2007

Comments:
- The requirements of DIN 4109 only apply for the Installation sound level L_{In} measured in the test room UG rear.
- By using supporting clamps the details of attachment strongly affects the acoustical properties of the system. Only if the assembly instructions of the manufacturer are obeyed exactly and the weight of the system is distributed evenly on all fastening elements, a reproducible acoustical behaviour is reached. Otherwise possibly deviations from the measured values may occur.

Fraunhofer Institut Bauphysik

The tests were performed in a laboratory accredited by the German Accreditation System for Testing (DAP, file no. PL-3743.26) according to standard EN ISO/IEC 17025.

Stuttgart, November 26, 2008

Head of Laboratory:

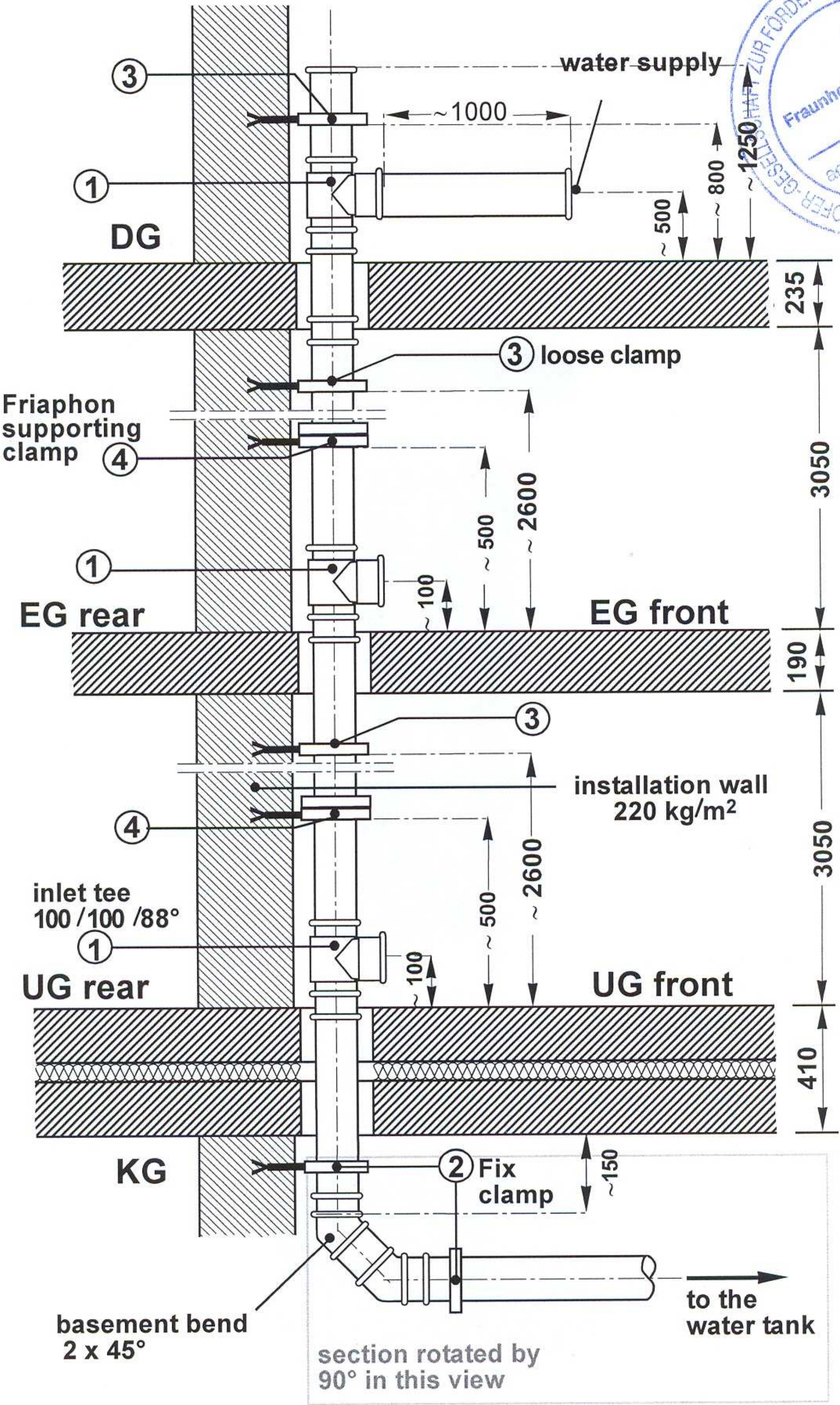


Figure 4 Installation plan of the pipe system "FRIAPHON M1" mounted with "FRIAPHON supporting clamps" manufactured by FRIATEC AG (drawing not to scale, dimensions in mm).

Measurement set-up, noise excitation and evaluation parameters

Measurement set-up

In the water-installation test-facility run by the Fraunhofer Institute of Building Physics, a down pipe is installed leading from the top floor (DG) down to the sub-basement (KG) (for further details, please see Annex P). This down pipe is connected to a (OD 110) water inlet pipe on the top-floor level. The water is introduced through an S-shaped bend according to the standard EN 14366 of February, 2005. In the sub-basement, the down pipe is connected to a bend (2 x 45 degree, usually) and merges into a horizontal discharge section, which in turn is joined to a water receptacle. The waste-water pipe on the ground floor (EG) and in the basement (UG) is fitted with conventional branches from main lines (usually, OD 110). Pipes and fittings are mounted according to the instructions given by the manufacturer. The air gaps between the tube and floor in the entrance and exit openings are stuffed with porous absorber in order to prevent any structure-borne sound bridges influencing the building. The waste-water piping is fastened to the installation wall (mass per unit surface m'' = 220 kg/m^2) by means of pipe clamps supplied by the Client, which are adapted to the external diameter of the pipes. The locations of the fixation points and further dimensions are specified in the installation plan that is included in the test report.

Noise excitation and evaluation parameters

Any defined and metrological reproducible noise excitation requires steady state flow conditions inside the waste-water pipes. As the noise generation in waste water systems depends on the flow rate, noise measurements are performed at several flow rates Q which are typically encountered in practice:

(1) Q = 0.5 l/s, corresponding to Q = 30 l/min,
(2) Q = 1.0 l/s, corresponding to Q = 60 l/min,
(3) Q = 2.0 l/s, corresponding to Q = 120 l/min,
(4) Q = 4.0 l/s, corresponding to Q = 240 l/min.

Here, a flow rate of Q = 2.0 l/s roughly corresponds to the average flow rate required for flushing a toilet. According to Prandtl-Colebrook, the highest flow rate used results from the admissible hydraulic charge of the horizontal pipe sections, which is Q_{max} = 4 l/s for OD 110 pipes.

The measurements take place in the installation room (UG front) and in the room behind the installation wall (UG rear). The water flow generates vibrations of the wastewater pipe. These vibrations are transmitted to the installation wall through pipe clamps and/or other structure-borne sound bridges (e.g. fire protection sleeves), and then radiated by the wall (and to a lesser extent, also by the adjoining building parts) as airborne sound into the test room behind the installation wall. In the test room UG front additionally the airborne sound which is radiated from the waste water system is measured. According to EN ISO 140-3:2005 the sound pressure level is picked up at six points in the room, to be space and time-averaged and corrected for the background noise. With this value the airborne sound pressure level $L_{a,A}$ and the structure-borne sound characteristic level $L_{sc,A}$ is calculated according to EN 14366. The installation sound level is determined following Annex F. Thereby the rounded $L_{AF,10}$ is equivalent to the installation sound level L_{In} according to DIN 52219 and DIN 4109.

Evaluation of Measurements

Stationary noise

The measured sound pressure level is given as a time and space averaged one-third octave spectrum in the frequency range between 100 Hz and 5 kHz. First, the value is corrected for background noise. Subsequently, the measurement signal is normalized to an equivalent sound absorption area A_0 = 10 m^2 and A-weighted:

(1) $$L_{n,AF,10} = 10 \cdot \lg\left(10^{\frac{L_{n,F}}{10}} - 10^{\frac{L_{n,S}}{10}}\right) + 10 \cdot \lg\frac{A_n}{A_0} + k(A)_n$$ [dB(A)]

$L_{n,F}$	space and time averaged sound pressure level in one-third octave band n (time constant: Fast)	[dB]
$L_{n,S}$	background noise level in one-third octave band n	[dB]
$A_n = \frac{0.16 \cdot V}{T_n}$	sound absorption area of test room for one-third octave band n	[m^2]
V	volume of test room	[m^3]
T_n	reverberation time of test room in one-third octave band n	[s]
$k(A)_n$	A-weighting for one-third octave band n	[dB]

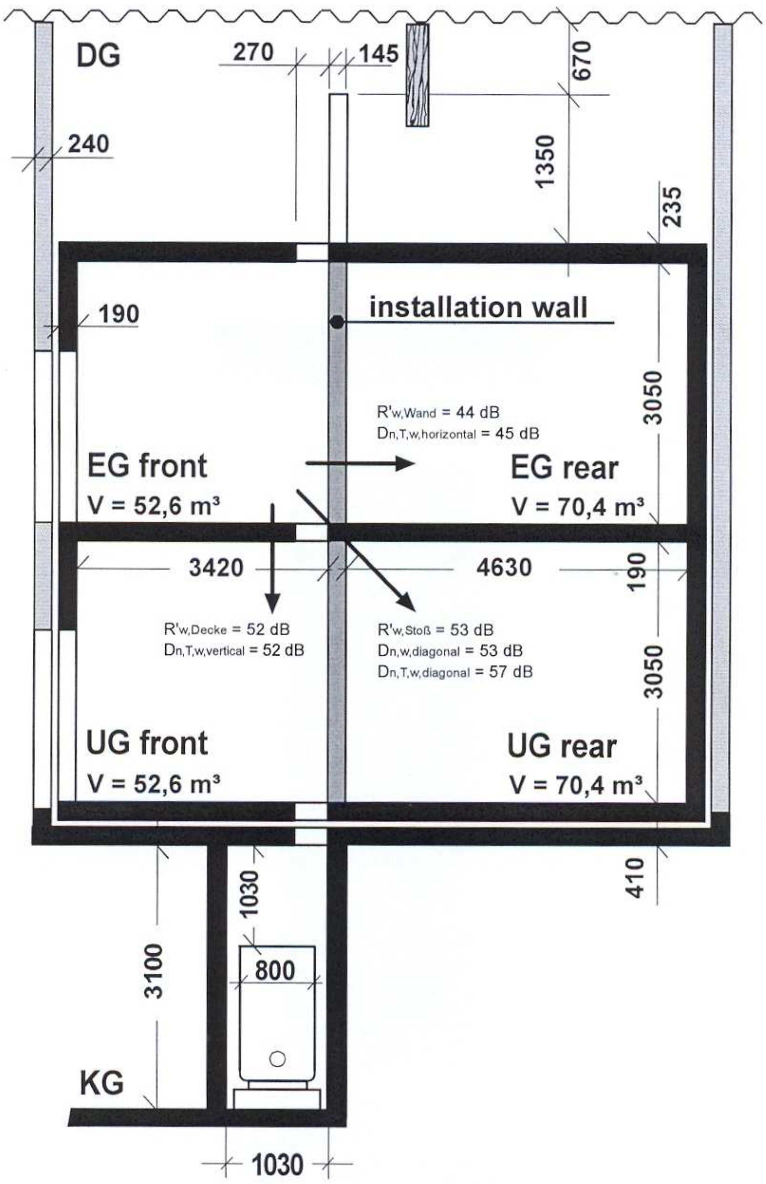
If the difference between the two levels (i.e. the measured one-third octave level and the background noise level) is less than 3 dB, the correction for background noise will not be performed. Instead, the measured background noise level will be used (as an estimated maximum level). The total sound pressure level is obtained by energetically adding the one-third octave values.

(2) $$L_{AF,10} = 10 \cdot \lg\left(\sum_{n=1}^{18} 10^{\frac{L_{n,AF,10}}{10}}\right),$$ [dB(A)]

where n indicates the number of one-third octave bands from 100 Hz through 5 kHz. The calculated level $L_{AF,10}$ corresponds to the sound pressure level resultant in a sparsely furnished reception room under otherwise equal conditions. The value ($L_{AF.10}$) is used as the installation sound level L_{In} in the test facility.

Noise variable with time

In this case, the measurement signal consists of a series of one-third octave spectra (frequency range from 100 Hz through 5 kHz) which are consecutively measured in the same place at a time interval of 0.125 s. The evaluation is performed in the same way as in the case of stationary noise, except for the background noise correction which is dropped. Subsequently, the maximum value ($L_{AF,10,max}$) is determined from the time profile.



Sectional drawing of the installation test facility in the Fraunhofer-Institute of Building Physics (dimensions given in mm). The test facility comprises two couples of rooms in the ground floor (EG) and in the basement (UG) that are located above each other. Due to this construction, including the top floor (DG) and the sub-basement (KG), it is possible to perform tests on installation systems which extend across several floors, e.g. waste-water installation systems. The installation walls in the ground floor and in the basement can be substituted according to actual requirements. In the standard case, single-leaf solid walls with a mass per unit area of 220 kg/m² (according to German standard DIN 4109) are used. Since the sound insulation of these walls do not meet the requirements to be fulfilled by a wall separating different occupancies within the same building ($R'_w \geq 53$ dB), the next adjacent rooms to be protected from noise are located diagonally above or below the installation room (in case of a usual design of the ground plan). Due to its double-leaf construction with an additional structure-borne sound insulation, the installation test facility is particularly suited for measuring low sound pressure levels. The measuring rooms are designed in such a way that the reverberation times are between 1 s and 2 s within the examined frequency range. The flanking walls, with an average mass per unit area of approximately 440 kg/m², are made of concrete.