Benchmark case: Radiatterer

Description

A radiatterer is a geometry that both acts as a radiator of sound as well as it scatterers the radiated sound waves, see Figure 1. The geometry is a single cuboid of size $(x, y, z) = (2.5, 2.0, 1.7)$ m. From this cuboid 21 smaller cuboids have been cut out, cf. geometry table. This introduces open cavities, including a Helmholtz resonator, and many corners and edges. From this complex structure, multiple diffraction and resonance effects are to be expected. All surfaces are in parallel to the axes of the global cartesian coordinate system, and all angles are consequently an integer multitude of $\pi/2$ radians.

Several scenarios are suited for this geometry. The radiatterer could serve as an obstacle scattering incident waves or/and as a vibrating structure which is radiating sound. In a first case, a pure radiation problem is investigated. For this, a unit particle velocity normal to all surfaces is prescribed, i.e., v_n equals 1 mm/s. The frequency range is limited up to 1 kHz to allow solutions by using a conventional boundary element method. Future solutions may use finer meshes for higher frequencies.

The radiatterer and selected solutions are described in [1, 3]. The code Akusta has been used for many years [2, 4–6].

Name	Radiatterer
Field	Linear Acoustics
Code	coded UN3–2|SRF
Categories	
Bounded or Unbounded problems	Unbounded
Dimensionality of the case	3D
Scattering or Radiation problem	Scattering—Radiation
Time–domain or Frequency–domain problem	Frequency domain
Description	
PDE	Helmholtz Equation
Geometry	See appended Table and Figure 1 below.
Propagation medium	Air ($\rho = 1.3$ kg/m^3, $c = 340$ m/s)
BCs	$Z = \infty$ at boundaries
Source	$v_n = 1$ mm/s at all surfaces
Receiver	P_1 at $(x, y, z) = (-0.3, 0.3, 0.0)m$
	P_2 at $(x, y, z) = (0.2, -0.3, 0.4)m$
	P_3 at $(x, y, z) = (0.0, 0.0, -0.3)m$
	P_4 at $(x, y, z) = (0.5, 1.6, 0.8)m$
	P_5 at $(x, y, z) = (0.6, 0.5, 0.8)m$
	P_6 at $(x, y, z) = (2.0, 0.5, 0.8)m$
Quantity to compute	Acoustic pressure
	Radiated sound power in [3]
	Frequencies for computation:
	0.5 to 1000 Hz, with 0.5 Hz increment

References

[1] M. Hornikx, M. Kaltenbacher, and S. Marburg. A platform for benchmark cases in computational acoustics. *Acta Acustica united with Acustica*, 2014. (under review).

[2] S. Marburg. Six boundary elements per wavelength. Is that enough? *Journal of Computational Acoustics*, 10:25–51, 2002.

[3] S. Marburg. The Burton and Miller method: Unlocking another mystery of its coupling parameter. *Journal of Computational Acoustics*, page 20 pages, 2015. (under review).

[4] S. Marburg and S. Amini. Cat's eye radiation with boundary elements: Comparative study on treatment of irregular frequencies. *Journal of Computational Acoustics*, 13:21–45, 2005.

[5] S. Marburg and S. Schneider. Influence of element types on numeric error for acoustic boundary elements. *Journal of Computational Acoustics*, 11:363–386, 2003.

[6] S. Marburg and S. Schneider. Performance of iterative solvers for acoustic problems. Part i: Solvers and effect of diagonal preconditioning. *Engineering Analysis with Boundary Elements*, 27:727–750, 2003.

Geometrical details

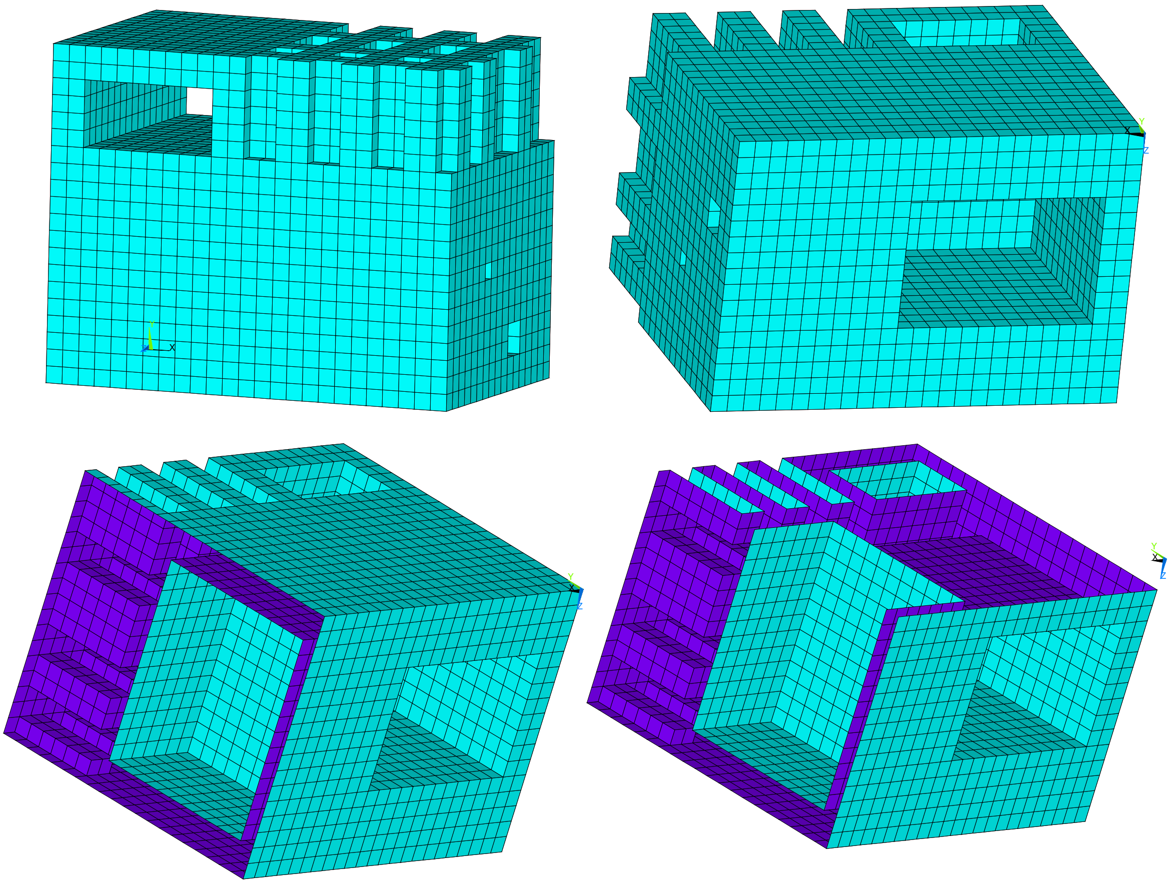

Figure 1: Benchmark case 'Radiatterer', coded UN3–2|SRF.

Geometry of the complex radiatterer, blocks no 2–22 subtracted from block 1

Block No.	$[x_{\min}, x_{\max}]$	$[y_{\min}, y_{\max}]$	$[z_{\min}, z_{\max}]$
1 (basis)	$[0.0, 2.5]$	$[0.0, 2.0]$	$[0.0, 1.7]$
2	$[0.2, 1.4]$	$[0.0, 1.2]$	$[0.4, 1.2]$
3	$[2.3, 2.5]$	$[0.2, 0.4]$	$[0.5, 0.7]$
4	$[2.3, 2.5]$	$[0.7, 0.8]$	$[1.0, 1.1]$
5	$[1.6, 2.3]$	$[0.1, 1.2]$	$[0.2, 1.5]$
6	$[0.2, 1.0]$	$[1.4, 1.8]$	$[0.0, 1.7]$
7	$[1.2, 1.4]$	$[1.4, 2.0]$	$[1.6, 1.7]$
8	$[1.6, 1.8]$	$[1.4, 2.0]$	$[1.6, 1.7]$
9	$[2.0, 2.2]$	$[1.4, 2.0]$	$[1.6, 1.7]$
10	$[2.4, 2.5]$	$[1.4, 2.0]$	$[1.6, 1.7]$
11	$[1.2, 1.4]$	$[1.4, 2.0]$	$[1.2, 1.4]$
12	$[1.6, 1.8]$	$[1.4, 2.0]$	$[1.2, 1.4]$
13	$[2.0, 2.2]$	$[1.4, 2.0]$	$[1.2, 1.4]$
14	$[2.4, 2.5]$	$[1.4, 2.0]$	$[1.2, 1.4]$
15	$[1.2, 1.4]$	$[1.4, 2.0]$	$[0.6, 1.0]$
16	$[1.6, 1.8]$	$[1.4, 2.0]$	$[0.6, 1.0]$
17	$[2.0, 2.2]$	$[1.4, 2.0]$	$[0.6, 1.0]$
18	$[2.4, 2.5]$	$[1.4, 2.0]$	$[0.6, 1.0]$
19	$[1.2, 1.4]$	$[1.4, 2.0]$	$[0.0, 0.4]$
20	$[1.6, 1.8]$	$[1.4, 2.0]$	$[0.0, 0.4]$
21	$[2.0, 2.2]$	$[1.4, 2.0]$	$[0.0, 0.4]$
22	$[2.4, 2.5]$	$[1.4, 2.0]$	$[0.0, 0.4]$