1LP4-02

Comparative analysis of the specific characteristics of the magnetic bearings with HTS elements

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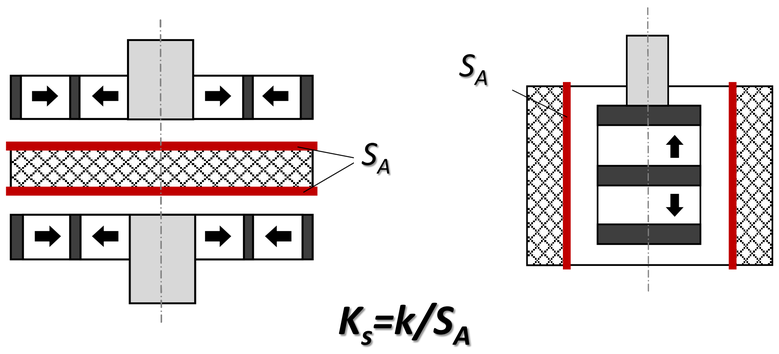
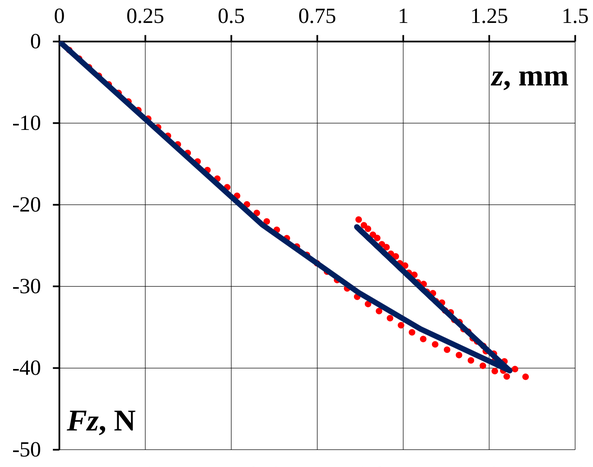
Specific stiffness



$$K_s = k/S_A$$

where k – stiffness of the bearing, S_A – active surface of the HTS (surface acting with permanent magnets)

Calculation and experiment of the HTS bearing

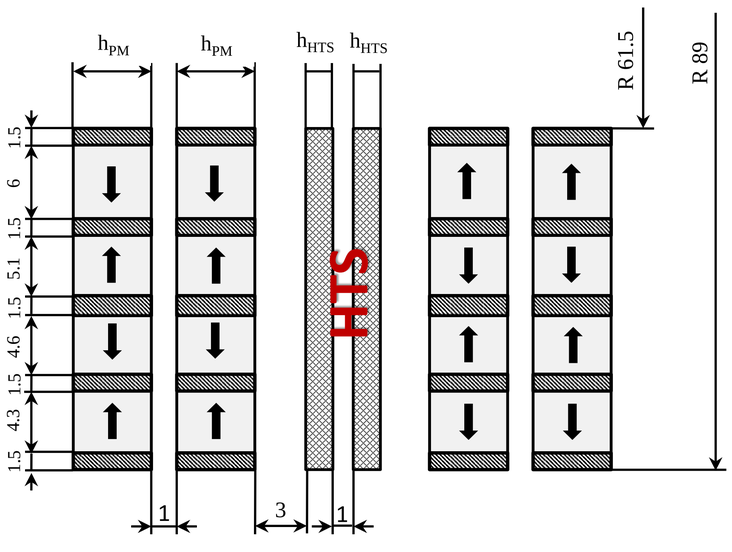


Dependences of the axial force on the axial displacement

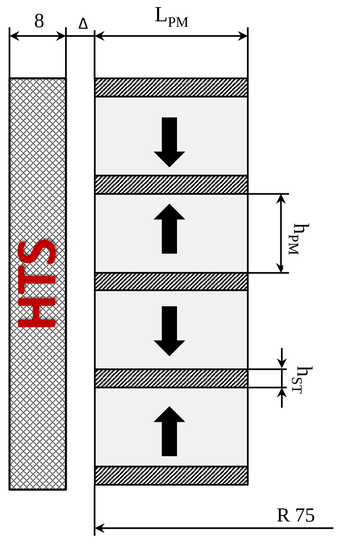
Prototype of HTS bearing

1 – fixed base, 2 – cooling system, 3 – cooper rings for axial load during experiment, 4 – non-magnetic disk (rotor), 5 – motion sensor

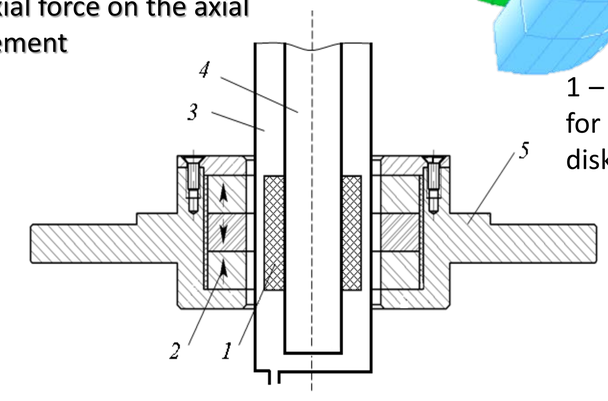
Type of construction



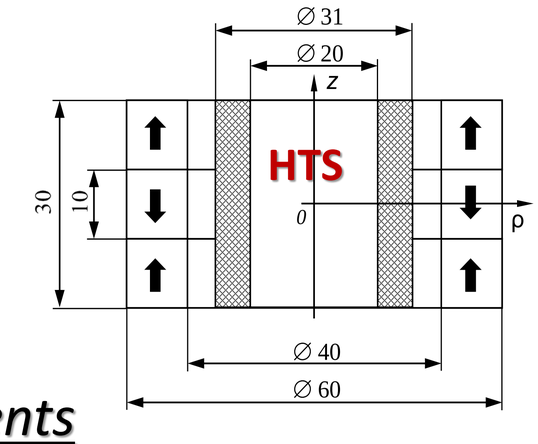
1. Disk HTS bearing



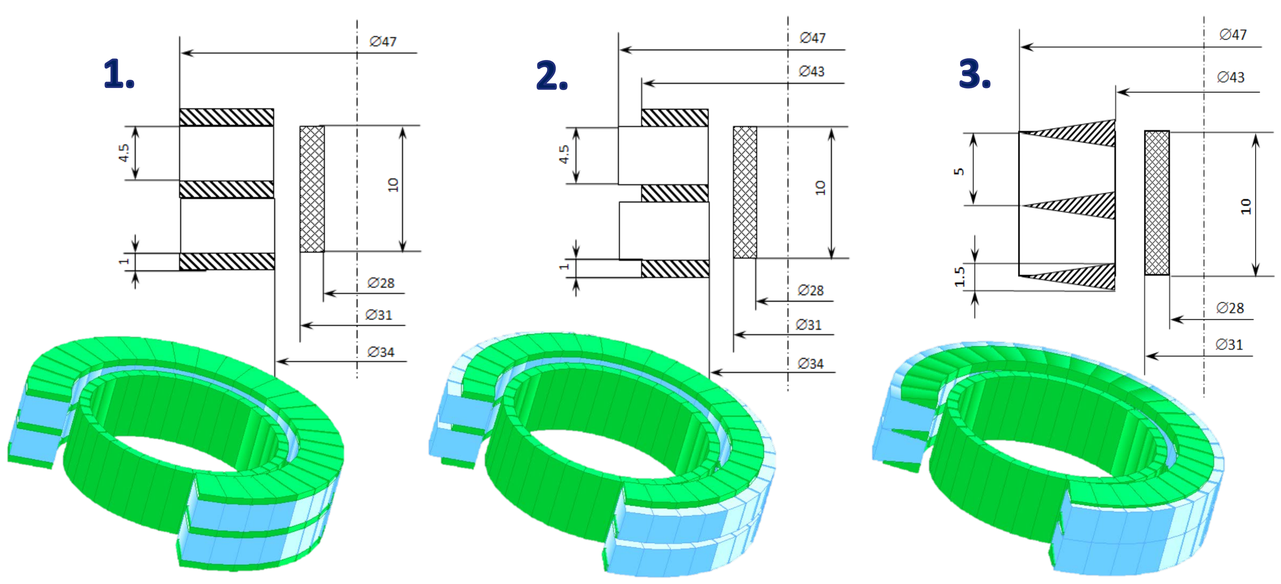
2. Cylindrical HTS bearing



1 – HTS rings (stator), 2 – permanent magnets (rotor), 3 – vacuum insulation, 4 – cooling system, 5 – non-magnetic disk



Shape of the steel elements



1.

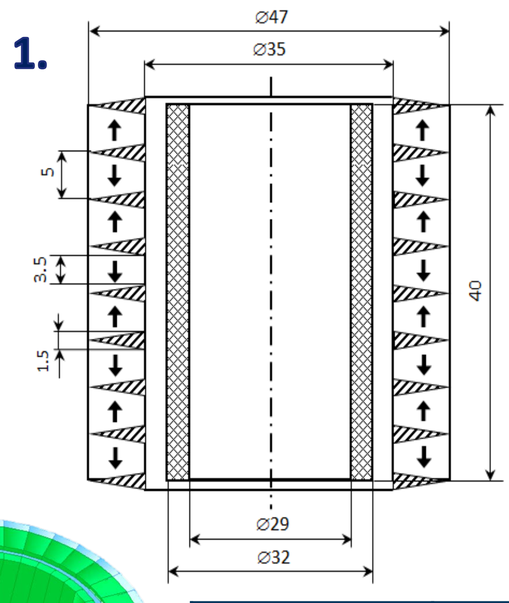
h_{HTS}, mm	h_{PM}, mm	Specific axial stiffness, N/(mm*cm²)	Specific radial stiffness, N/(mm*cm²)
2	4	0.70	0.45
2	8	1.07	0.71
3	4	0.81	0.41
3	8	1.23	0.63
4	4	0.85	0.39
4	8	1.29	0.40

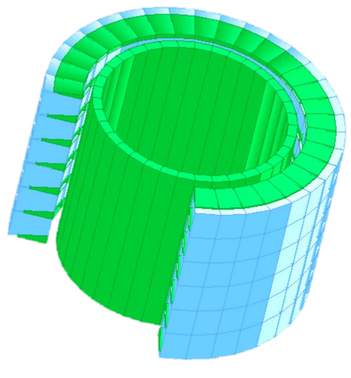
2.

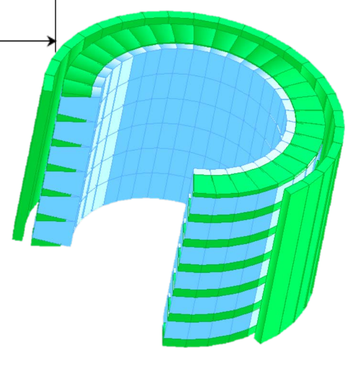
L_{PM}, mm	h_{PM}/h_{ST}, mm	Specific axial stiffness, N/(mm*cm²)	Specific radial stiffness, N/(mm*cm²)
15	6/2	1.76	0.95
15	8/3	2.06	1.06
15	12/4	2.19	0.90
15	16/5	2.08	0.80
20	6/2	1.99	1.09
20	8/3	2.42	1.14
20	12/4	2.66	1.11
20	16/5	2.63	1.02
25	6/2	2.10	1.17
25	8/3	2.69	1.35
25	12/4	3.00	1.16
25	16/5	3.07	1.22

Type of the steel elements	Specific axial stiffness, N/(mm*cm²)	Specific radial stiffness, N/(mm*cm²)
1. Square	2,4	1,64
2. Short square	2,65	1,92
3. Triangular	2,79	1,94

Inner and outer stator







Type	Specific axial stiffness, N/(mm*cm²)	Specific radial stiffness, N/(mm*cm²)
1. Inner stator	2.98	1.94
2. Outer stator	2.84	1.86

Conclusion

Theoretical research of the specific parameters of HTS bearing was performed by 3-D analysis of electromagnetic field. Applied method was confirmed by the study of the prototype of HTS bearing.

Two types of HTS bearing with disk and cylindrical superconducting stator were considered. Calculations show the influence of shape of the steel elements in magnetic system of the rotor and the possibility to increase the stiffness of HTS bearing. Also the results of the research confirm the effectiveness of HTS bearing with inner rotor, which may be useful in high speed flywheels.

Quantitative evaluation of the specific stiffness for different constructions allows to effectively select the HTS bearing for any device with magnetic suspension.

This work was supported by the Ministry of Education and Science of the Russian Federation. Project number: 8.9603.2017 / 8.9.