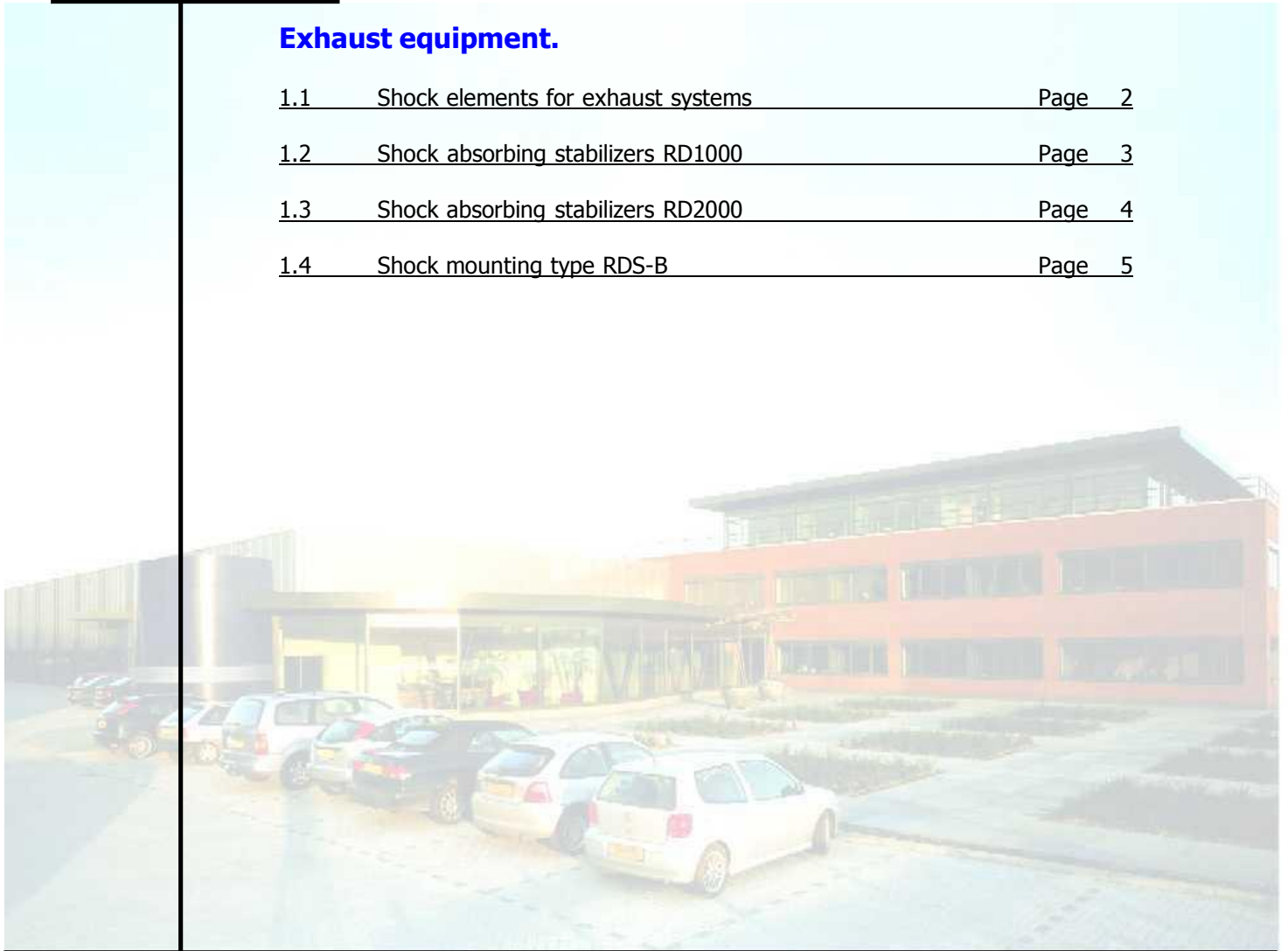


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## 1.1 Shock elements for exhaust systems

Rubber Design is one of the leading companies in the field of shock and vibration control on board naval vessels. As a provider of shock and vibration solutions, Rubber Design is continuously exploring innovative shock calculation methods, as well as developing new type of shock mountings by using finite elements computer programs. Rubber Design sets the pace for answering international military demands by designing a new generation of shock mounts, with a minimum of shock transmission and a maximum of vibration isolation.

In every situation where diesel engines are used, noise and vibrations will be generated! As well through the engine foundation, engine disturbance will travel along the exhaust system to be transmitted into the vessel wherever the system is in contact with the ships structure. Rubber Design BV has the experience and solutions to control these vibration and noise emissions from the exhaust system.

By flexibly mounting not only the engine but also the exhaust system, we can control most of these unwanted noise emissions. A significant reduction in the radiated noise and vibration can be achieved by introducing rubber-metal elements between the exhaust system and ship's structure.

For an explanation of how the noise reduction is achieved, the transmission speed of sound through steel and rubber needs to be understood. The transmission speed through steel is approximately 5000 m/sec. while through rubber, the transmission speed is approximately 45 to 90 m/sec.

By careful design and positioning of the rubber-metal elements it is possible to obtain a reduction of 8 to 10 dB (A) across the majority of the frequency range of 63 to 4000 Hz.

To give the optimum isolation, the number of mountings are kept to a minimum and positioned at strengthened locations in the ship's structure, for example deck levels, frame webs or specially

constructed supports. Every installation takes into account the weight of the appropriate section of the system, the forces produced by ship movements and thermal expansion effects.

It is equally important to ensure the frequencies, produced by any part of the exhaust system, are not the same as the frequencies caused by the engine ignition, the first order frequencies of the engine or the propeller blade frequency.

### Types of mounting.

Two basic types of mounting are used, fixed support mountings and stabiliser mountings. The fixed support mountings absorb the static and dynamic forces and determine the direction of the expansion in the exhaust system. The stabiliser mountings allow the thermal expansion movement caused by the high temperature of the exhaust piping within the ship's structure to be controlled. In case of horizontal piping the stabiliser mountings also carry the weight of the pipe.

### Thermal insulation.

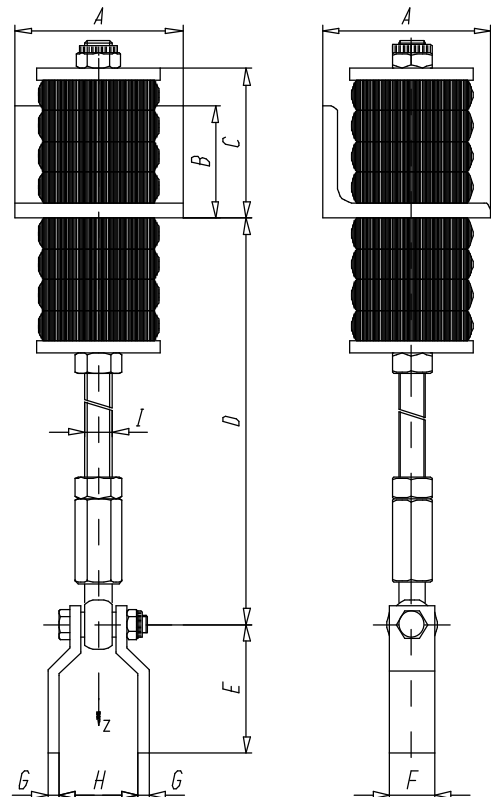
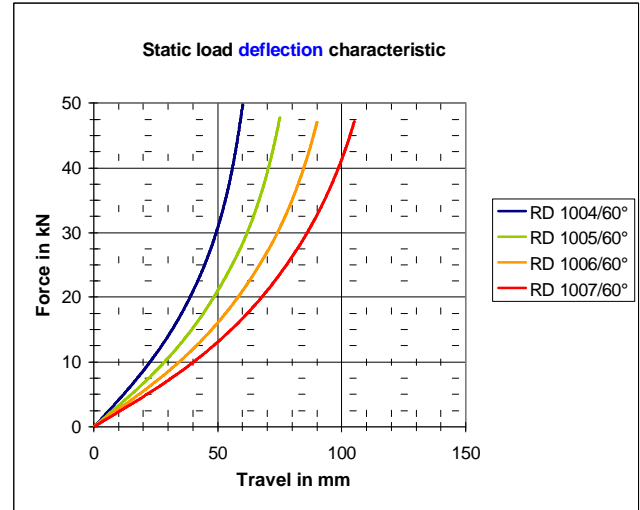
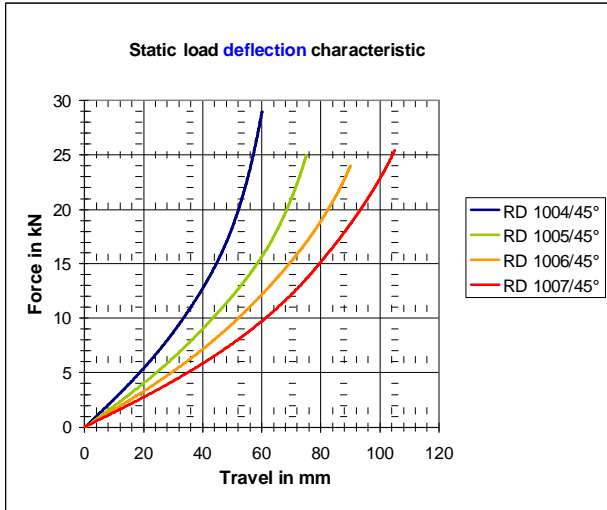
In order to protect the rubber against the high exhaust gas temperatures, it is necessary to install sufficient thermal insulation. It is essential to reduce the temperatures at the rubber-metal elements to less than 80°C. By using suitable insulation materials, it is possible to keep the temperature to a maximum of 50°C. It is always recommended to provide a minimum air gap of approximately 25 mm between the exhaust mounting and exhaust system. The above is applicable for the flexible fixed points, for the stabilisers the thermal insulation is attained to the length of the threaded rod.



## 1.2 Shock absorbing stabilizers RD1000.

These stabilizers are built with components of our proven standard stabilizers, but with extra rubber discs added. The extra discs extend the maximum deflection, so the stabilizer can absorb a larger shock. Adding discs results in decreasing stiffness, combined with increased deflection.

At the moment, there are eight types available. When choosing one of them, it is recommended to let us give advice for the suspension of your exhaust gas system. When the exhaust system requires a special kind of stabilizer, Rubber Design is able to develop them. That also counts for special pipeplates, materials or any other properties.

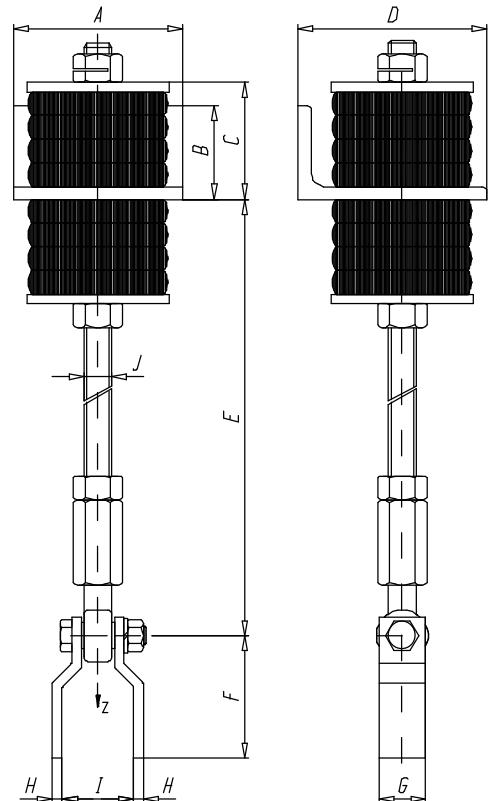
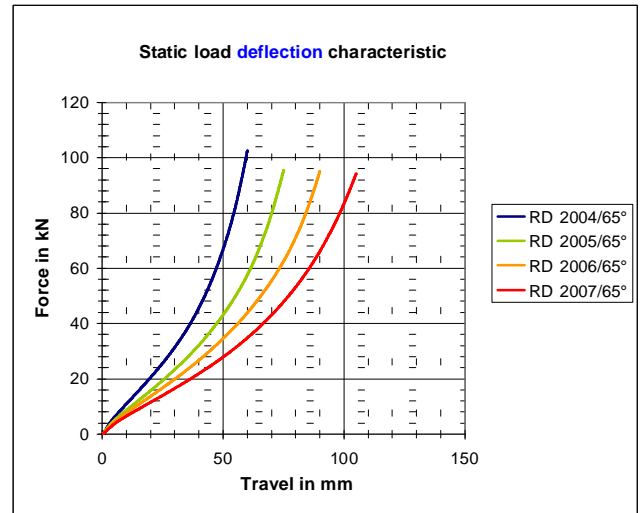
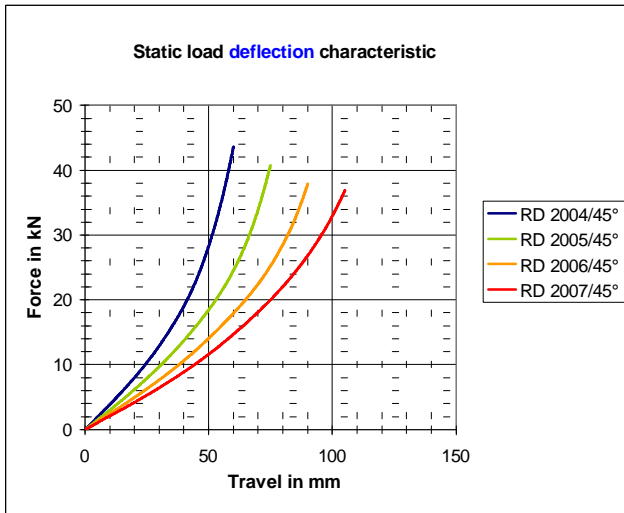


Type	Qty discs	A	B	C	D	E	F	G	H	I	Max static load 45°/60°	Weight
RD1004	2 x 4	150	100	116	461	115	40	10	71	M24	3.9 kN / 6.3 kN	11.2 kg
RD1005	2 x 5	150	100	139	438	115	40	10	71	M24	2.9 kN / 4.9 kN	11.7 kg
RD1006	2 x 6	150	100	162	415	115	40	10	71	M24	2.4 kN / 4.1 kN	12.2 kg
RD1007	2 x 7	150	100	185	392	115	40	10	71	M24	2.1 kN / 3.4 kN	12.7 kg

### 1.3 Shock absorbing stabilizers RD2000.

These stabilizers are built with components of our proven standard stabilizers, but with extra rubber discs added. The extra discs extend the maximum deflection, so the stabilizer can absorb a larger shock. Adding discs results in decreasing stiffness, combined with increased deflection.

At the moment, there are eight types available. When choosing one of them, it is recommended to let us give advice for the suspension of your exhaust gas system. When the exhaust system requires a special kind of stabilizer, Rubber Design is able to develop them. That also counts for special pipeplates, materials or any other properties.



Type	Qty discs	A	B	C	D	E	F	G	H	I	J	Max static load 45°/60°	Weight
RD2004	2 x 4	180	100	116	200	456	130	50	10	76	M30	5.8 kN / 15.6 kN	17.2 kg
RD2005	2 x 5	180	100	139	200	433	130	50	10	76	M30	4.5 kN / 12.1 kN	18.0 kg
RD2006	2 x 6	180	100	162	200	410	130	50	10	76	M30	3.6 kN / 10.7 kN	18.9 kg
RD2007	2 x 7	180	100	185	200	387	130	50	10	76	M30	3.1 kN / 9.0 kN	19.7 kg

### 1.4 Shock mounting type RDS-B

This mounting is used as a semi-rigid mounting, capable for shock absorption in exhaust gas systems. The mounting, like the flexible stabilizers mentioned before, is based upon proven technology from our flexible exhaust suspension equipment. Isolation plates protect the rubber inside the mounting from high temperature

exposure. Placed in between normal vibration isolators and large displacement shock mountings, this mounting is capable of providing adequate shock protection to non-sensitive equipment, and providing good vibration isolation under harsh conditions.

