Technical Bulletin 102

Load Cases for the Design of Hull Foundations for the Seakeeper M7000 Gyro

Loads for designing a hull foundation for the Model 7000 Gyro are shown on Sheet 5 of Seakeeper Drawing 90002 Gyro Installation Details. This drawing can be downloaded at www.seakeeper.com. The loads were developed by analyzing many different loads cases (i.e. operational scenarios). To simply foundation design, Seakeeper specified that the highest individual forces and moments from the different load cases be applied as if they acted simultaneously and on the port and the starboard gyro saddle beams. This results in a conservative design.

The table on the next page provides the individual load cases for builders and naval architects who want to design the gyro foundations in a more rigorous manner by doing structural analysis (e.g. an FEA) of each individual case. Loads are given for six design cases that are considered critical for hull foundation strength. The cells with blue background show the loads provided on Seakeeper Drawing 90002.

Load Cases 1 and 2 are with the gyro in the Sea mode at maximum precession rate combined with the gyro unit subject to inertial loads due to large vertical, transverse and longitudinal boat accelerations. Load Cases 1 and 2 are essentially static strength cases because such high accelerations will occur infrequently during the life of a boat.

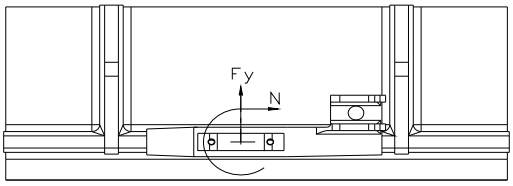
Load Cases 1a and 2a are with the gyro in the Sea mode at maximum precession rate with the acceleration loads set to zero. These are fatigue load cases that represent what the gyro foundation in an offshore supply boat or offshore fishing boat might see in daily service at zero speed. The designer should assume that these loads fully reverse every cycle from positive to negative and back to positive at the vessel's natural roll period (assume a 3 second roll period if the actual roll period is not known).

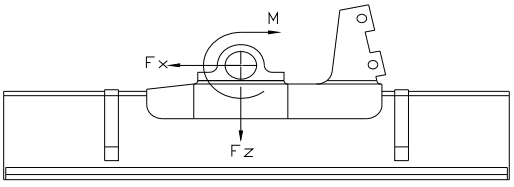
Load Cases 3 and 4 are with the gyro in the Lock Mode with the boat subject to a large uncontrolled roll velocity (rad/sec) and with the gyro subject to inertial loads due to large vertical, transverse and lateral boat accelerations. Load Cases 3 and 4 are also static strength cases since the gyro will not be locked under these conditions except in case of a malfunction and such high accelerations will occur infrequently during the life of the vessel.

Each case is a consistent set of loads, that is, they all act at the same time. The loads given for the starboard foundation are consistent with the loads given for the port foundation and as such they are not necessarily the maximum loads for the starboard side. Individual loads from the brake cylinders are not shown; instead the loads are presented as resultants acting at the gimbal bearings. This should be adequate for hull foundation design. Nomenclature and positive load directions are shown in the figure on the next page.

The boat builder or designer is responsible for designing the hull foundation to which the gyro is attached to accommodate the forces and moments shown in the table taking into account fatigue, variations in as-built material properties, good engineering practice etc. A minimum Factor of Safety of 3 is recommended. The builder or designer is also responsible for selecting the structural adhesive to secure the saddle beams to the hull beams. The calculated maximum shear stress in the adhesive between the saddles and the hull foundation beams for the various load cases and 100% adhesive contact is 2.3 MPa (337 psi). Seakeeper recommends that the builder select an adhesive with a minimum shear strength of 13.8 MPa (2000 psi) to give a Factor of Safety of 6 (Margin of Safety of 5). It is also strongly suggested that the builder or installer test the compatibility of the adhesive with the cast A356 T6 aluminum beams by bonding cast pieces to the hull material and doing mechanical tests. Seakeeper can supply cast samples for these tests if requested.

	Sea Mode	Sea Mode	Sea Mode	Sea Mode	Lock Mode	Lock Mode
Type of Load Case	Static-Infrequent	Fatigue	Static-Infrequent	Fatigue	Static-Infrequent	Static-Infrequent
Gyro Roll Moment (kN-M)	-15.0	-/+15	-13.0	-/+13.0	0.0	0.0
Gyro Precession Moment (kN-M)	-3.0	-/+3	-3.0	-/+3	5.0	2.5
Gyro Yaw Moment (kN-M)	0.0	0.0	7.5	+/-7.5	0.0	0.0
Vertical Load Factor (g)	4.0	0.0	4.0	0.0	4.0	4.0
Transverse Load Factor (g)	1.0	0.0	1.0	0.0	1.0	1.0
Longitudinal Load Factor (g)	0.5	0.0	0.5	0.0	0.5	0.5
Port Beam						
Fz (kN)	23.5	+/-17.4	21.2	+/-15.0	6.1	6.1
Fx (kN)	0.8	0.0	**9.5**	+/-8.7	0.8	0.8
Fy (kN)	3.1	0.0	3.1	0	3.1	3.1
M (kN-M)	3.3	+/-3.3	3.3	+/-3.3	**-5.4**	-3.0
N (kN-M)	0.7	-/+0.7	0.8	-/+0.8	1.2	**1.4**
Starboard Beam						
Fz (kN)	-11.2	-/+17.4	-8.9	-/+15.2	6.1	6.1
Fx (kN)	0.8	0.0	-7.9	-/+8.7	0.8	0.8
Fy (kN)	0.0	0.0	0	0	0.0	0.0





Nomenclature for Foundation Loads

Port Beam Shown - Starboard Beam Nomenclature Similar - Positive Load Directions Shown