



How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

By Paul Steinmann
Product Manager – VEEM Marine



Less Motion, More Ocean

How the VEEM Marine Gyrostabilizer Range Generates Much Higher Stabilising Torque than its leading competitors.

We are often asked how the VEEM Marine Gyrostabilizer range generates so much more stabilising torque per unit of angular momentum, than its closest competitors.

An automotive analogy may assist in explaining how this works. We considered gyrostabilizer nameplate angular momentum in the same way as a racing car engine's capacity can be described by its nameplate swept volume. In both cases, the nameplate figures tell only a small part of the story of how exceptional performance is engineered.

We took inspiration from Formula 1 race car engines ... and re-engineered what is possible for gyrostabilization.

Here's how...

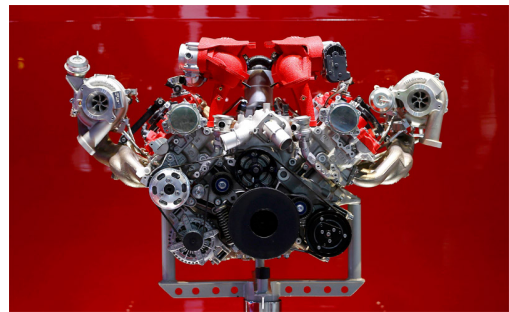
How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

F1 cars use much higher rpm than family cars to generate much higher brake horse power...from the same sized engine.

A 2016 Formula 1 (F1) racing car uses a 1.6 litre engine, which is similar in volume to a small domestic car. However, the F1 engine can generate many times the brake horse power of a 1.6 litre domestic car, using exactly the same swept engine volume. This is achieved by running at a much higher rpm.

An F1 car will operate at engine revs up to 15,000 rpm, compared to the small 1.6litre modern family car that revs up to around 6,000 rpm. There are many complex engineering features that combine to allow this level of performance, including:

- pneumatic valve springs,
- high tensile piston control rods,
- very short stroke (over-square),
- minimised con-rod bearing size,
- powerful multi-stage turbo chargers



F1 engines last about 6 months. The family car will last for over 20 years.

So, in effect we have created F1 performance, with family car reliability.

Of course the F1 car's chassis structure, drive train, suspension and braking system must also be engineered to handle the much higher power transmission. These features are just as important to the overall car performance as the engine power. You couldn't put an F1 engine in a small family car as it would rip the car apart and shred the tires.

We applied similar concepts to gyrostabilization. We generate massive roll stabilizing, but we also engineered the product to last for over 25 years, using comprehensive fatigue analysis on all structural components. In effect, we have created F1 performance, with family car reliability.

How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

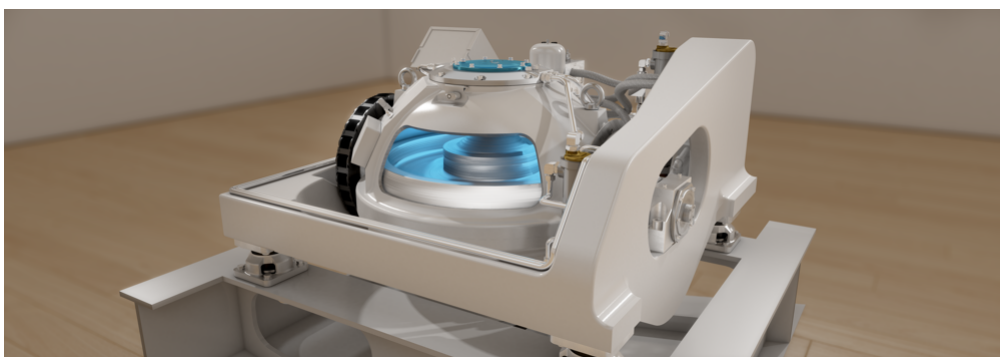
VEEM Marine Gyrostabilizer use higher precession rates to generate much higher stabilising torques than leading competitors.

The F1 high rpm concept is applicable to gyrostabilizers. The angular momentum, like a cars swept engine volume, is just one factor in generating high performance, or in the gyrostabilizer case, high stabilizing torque.

The angular momentum of a gyrostabilizer flywheel is the product of the distributed mass of the flywheel and the speed at which it spins. Higher speed equals higher angular momentum. More weight distributed on the rim as opposed to the centre of the flywheel equals more angular momentum.

Angular momentum is not the key to reducing rolling motion on ships. The torque generated by the gyrostabilizer to oppose wave induced rolling torques is what reduces rolling motion.

Angular momentum is like the swept volume of an internal combustion engine. The swept volume is described in CC for small engines and litres or cubic inches for larger engines. Higher swept volume of the pistons generally equates to higher brake horse power. But this is far from the whole story. For a given swept volume, like a given angular momentum, there is a very large range of possible brake horse power outputs. Similarly, for a given angular momentum, there is a very large range of possible roll stabilising torque.



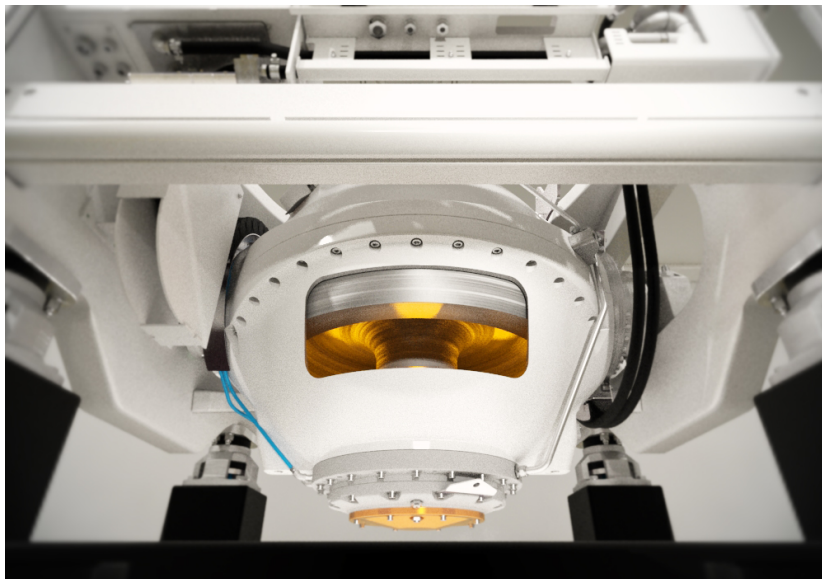
The stabilizing torque is the product of the angular momentum and the precession rate, or the speed with which the vacuum chamber containing the flywheel swings in the vessel longitudinal axis. This is where technology and engineering can come into play to seriously improve a gyrostabilizer's ability to generate stabilizing torque for a given angular momentum.

How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

VEEM Marine Gyrostabilizers use higher precession rates to generate much higher stabilizing torques than leading competitors...cont'

For gyrostabilizers, higher precession rate is equivalent higher rpm in race cars. There are two key factors that allow the VEEM Marine Gyrostabilizers to generate massive stabilizing torque as compared to its competitors: 1) the control system software is programmed to allow and promote faster precession rate, 2) the entire gyrostabilizer structure is built stronger in order to absorb the much higher torque loads. More on that next.

Higher target precession rates are programmed into the VEEM Marine Gyrostabilizers in order to promote higher stabilizing torque generation. To ensure that VEEM Marine Gyrostabilizers achieve maximum precession rates across a varying range of wave and vessel operating conditions, the software that controls the precession axis has to constantly adapt and update itself based on current conditions.



Theoretically, a gyrostabilizer can produce infinite torque, but the software is programmed to limit this to safe levels for the machine. The limits are defined by the machine's capacity to develop and absorb this torque.

How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

Exactly how VEEM Marine Gyrostabilizers generate much higher stabilizing torque.

The VEEM Marine Gyrostabilizer has been engineered from the inside out to withstand massive roll stabilizing torques. There are many engineered features of the VEEM Marine Gyrostabilizer that combine to allow this level of performance:

- Roller bearings supporting the flywheel within VEEM Marine Gyrostabilizers can accommodate several times more radial load as the ball bearings used in other systems
- Exceptionally strong and tough base frame structure is required to safely transmit the gyrostabilizer generated loads to the ship structure
- Large bore hydraulic lines minimise resistance to precession and maximise precession rate
- Adaptive software ensures that maximum precession rate is achieved across a wide range of sea conditions
- High capacity hydraulic oil coolers extract large amounts of energy from the ocean waves and dissipate this overboard
- High pressure hydraulic cylinders provide very large precession braking torques which allows the VEEM Marine Gyrostabilizer units to continue to operate in large waves without the need to shut down like other leading brands

So, even if other gyrostabilizers could generate similarly high stabilizing torque, the bearing life, structural fatigue life and hydraulic systems would not be able to support them.



How VEEM Marine Gyrostabilizers Create So Much Torque: Lessons from F1

CONCLUSION

Gyrostabilization has transformed expectations of comfort and safety in waves, at rest and underway.

VEEM Marine Gyrostabilizers have transformed what can be expected from gyrostabilization.

NEXT STEPS

To find out what VEEM Marine Gyrostabilizer options are suited to your project, use VEEM's online GyroSize calculator.

You will be emailed a comprehensive PDF report in minutes.

www.veemmarine.com

Use GyroSize



Less Motion, More Ocean