How VEEM Gyros Create so Much Torque : Lessons from F1

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Less Motion, More Ocean

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

We are often asked how the VEEM Gyro 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 gyro stabiliser 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 gyro stabilisation.

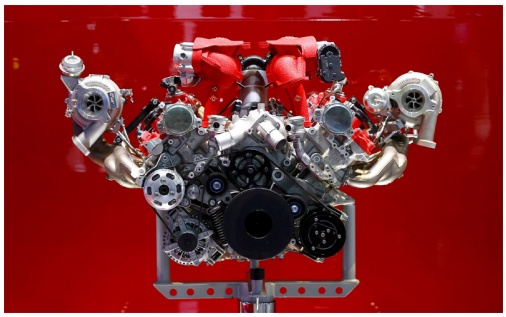
Here's how...

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.

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, it would rip the car apart and shred the tires.

We applied similar concepts to Gyro Stabilisation. We generate massive roll stabilising torques, but we also engineered the product to last for over 25 years, using comprehensive fatigue analysis or all structural components. So, in effect we have created F1 performance, with family car reliability.

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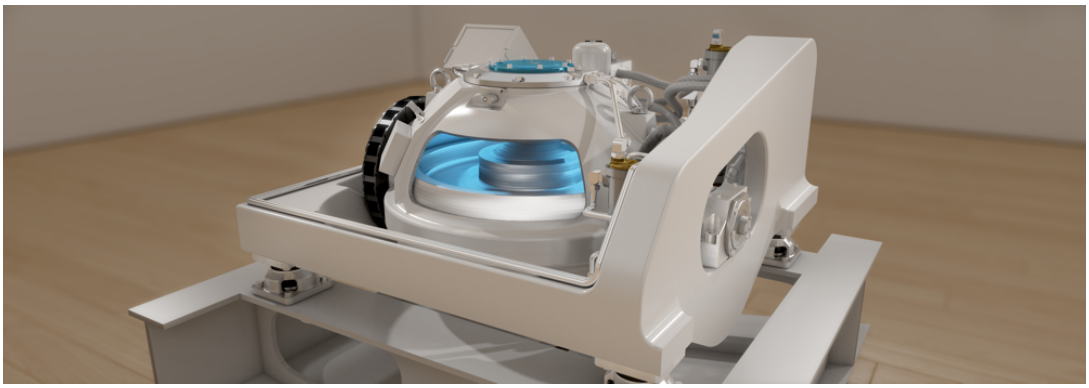
The F1 high rpm concept is applicable to gyro stabilisers. The angular momentum, like a cars swept engine volume, is just one factor in generating high performance, or in the gyro case, high stabilising torque.

The angular momentum of a gyro stabiliser 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 gyro stabiliser 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.

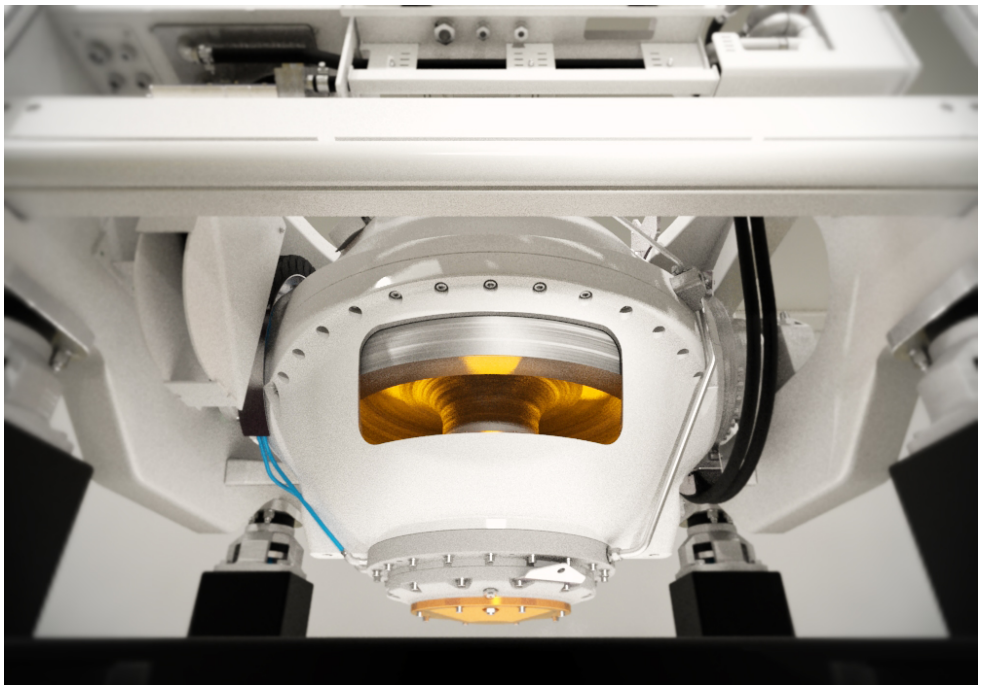


The stabilising torque is the product of the angular momentum and the precession rate, or the speed with which the vacuum chamber containing the flywheel swings in the vessel longitudinal axis. This is where technology and engineering can come into play to seriously improve a gyro stabiliser's ability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

VEEM Gyros use higher precession rates to generate much higher stabilising torques than leading competitors…cont'

For gyro stabilisers, higher precession rate is equivalent higher rpm in race cars. There are two key things that allow the VEEM Gyro to generate massive stabilising torque as compared to its competitors: 1) the control system software is programmed to allow and promote faster precession rate, 2) the whole gyro 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 Gyros in order to promote higher stabilising torque generation. In order to ensure that VEEM Gyro's 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 gyro stabiliser can produce infinite torque, but the software is programmed to limit this to safe levels for the machine. The limits are defined by the machines capacity to develop and absorb this torque.

Exactly how VEEM Gyros generate much higher stabilising torque.

The VEEM Gyro has been engineered from the inside out to develop and withstand massive roll stabilising torques. There are many engineered features of the VEEM Gyro that combine to allow this level of performance:

- Roller bearings supporting the flywheel within VEEM Gyro's can accommodate several times as much radial load as the ball bearings used in other systems
- Exceptionally strong and tough base frame structure is required to safely transmit the gyro 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 Gyro units to continue to operate in large waves without the need to shut down like other leading brands

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

CONCLUSION

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

VEEM Gyros have transformed what can be expected from gyro stabilisation.

VEEM Gyro

NEXT STEPS

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You will be emailed a comprehensive PDF report in minutes.

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