BALANCING MAGNETIC AND STRUCTURAL PERFORMANCE IN THE DESIGN OF LAMINATED MAGNETIC GEARS FOR MARINE ENERGY APPLICATIONS

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Magnetic gears are a technology that produce a non-contact means of transmitting torque by substituting the physical meshing of teeth in traditional gears with interacting magnetic fields. This eliminates many of the contact based failure mechanisms, such as abrasion and spalling, that can lead to premature failure in a mechanical gearbox as well as providing inherent overload protection. These attributes make mechanical gearboxes attractive in offshore wind and ocean energy applications, where they could reduce the operations and maintenance costs associated with servicing mechanical gearboxes.

Despite the lack of physical contact between the rotors, there are significant magnetic forces, which can cause rotor elements to deflect and eliminate the narrow air gaps needed for operation. The initial design of a 30 kW radial flux focusing magnetic gear employed utilized rotor elements that were manufactured from laminated steel stacks. These laminated components greatly underperformed the expected flexural stiffness, allowing deflections that eliminated the air gap between the low speed and high speed rotors. Several design changes were evaluated for increasing the flexural stiffness of the rotors; including larger diameter support rods, increased air gaps between the rotors, and intermediary support rings. The benefits of each change were weighted against the adverse impacts on the performance of the magnetic gear. Ultimately, a combination of these measures was effective in reducing the deflections, such that an air gap was maintained between the high and low speed rotors.

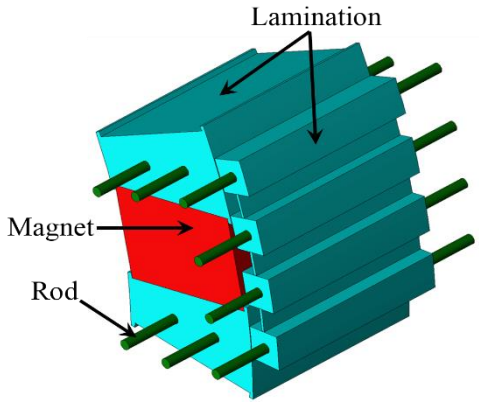

FIGURE 1. LAYOUT OF THE INNER AND CAGE ROTOR LAMINATIONS

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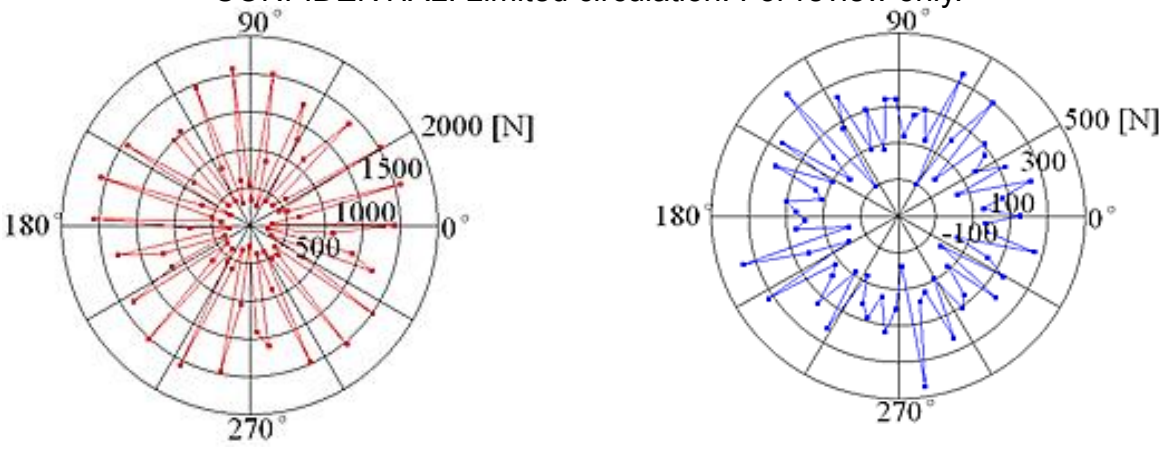

(a) (b)

FIGURE 2 FINITE ELEMENT ANALYSIS OF CALCULATED FORCES APPLIED TO THE RODS PASSING THROUGH CAGE ROTOR AS THE ROTOR WITH HIGHEST FORCE VALUES, (A) TANGENTIAL FORCES AND (B) RADIAL FORCES.

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