James Walker

Walkersele X-Gen: Seal Developments For Offshore Wind Energy

Elastomer Use in Sustainable Energy Webinar

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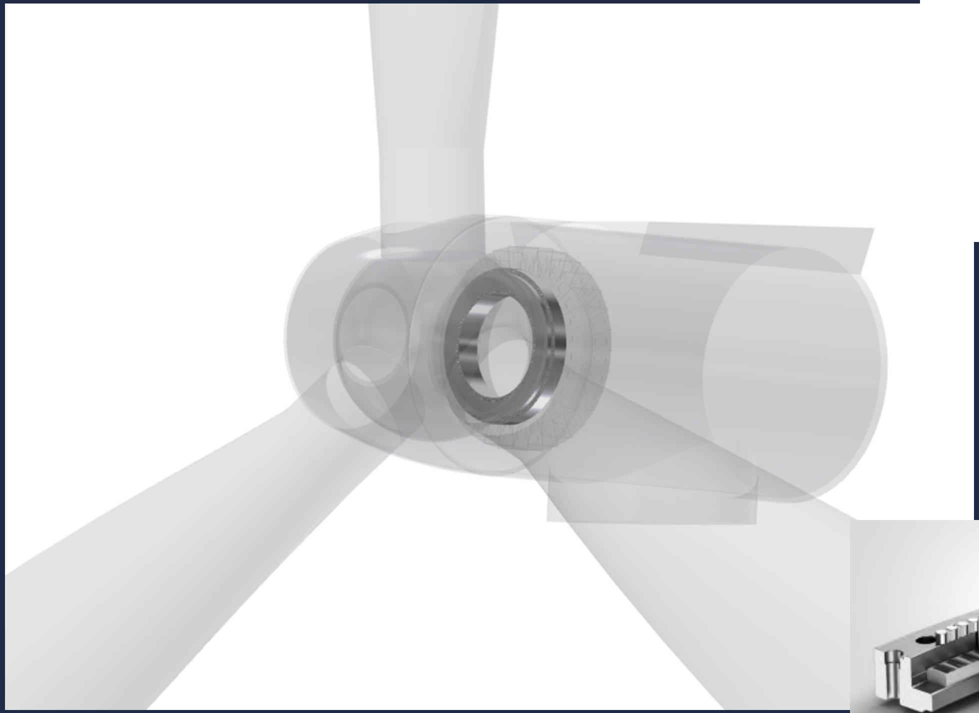
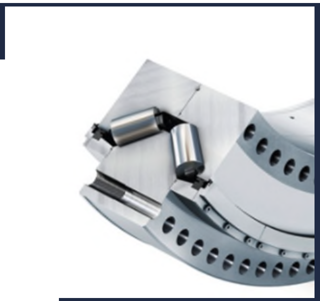
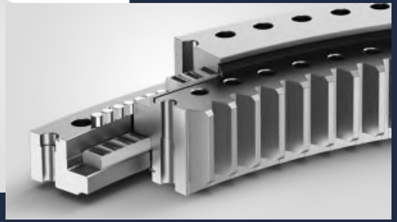
Walkersele X Gen: Overview

- A rotary lip seal developed to meet the sealing requirements for main shaft bearings in wind energy sector
- In particular, the offshore sector, where demand is for larger outputs, greater efficiency and greater utilisation
- Market is trending towards direct drive units, which have fewer moving parts versus geared turbines
- Trend for larger turbines, with greater outputs. In 2012 typical unit outputs were 2-4 MW. Today that has increased to 8-10MW, with units as large as 15MW being developed

The Main Shaft Bearing



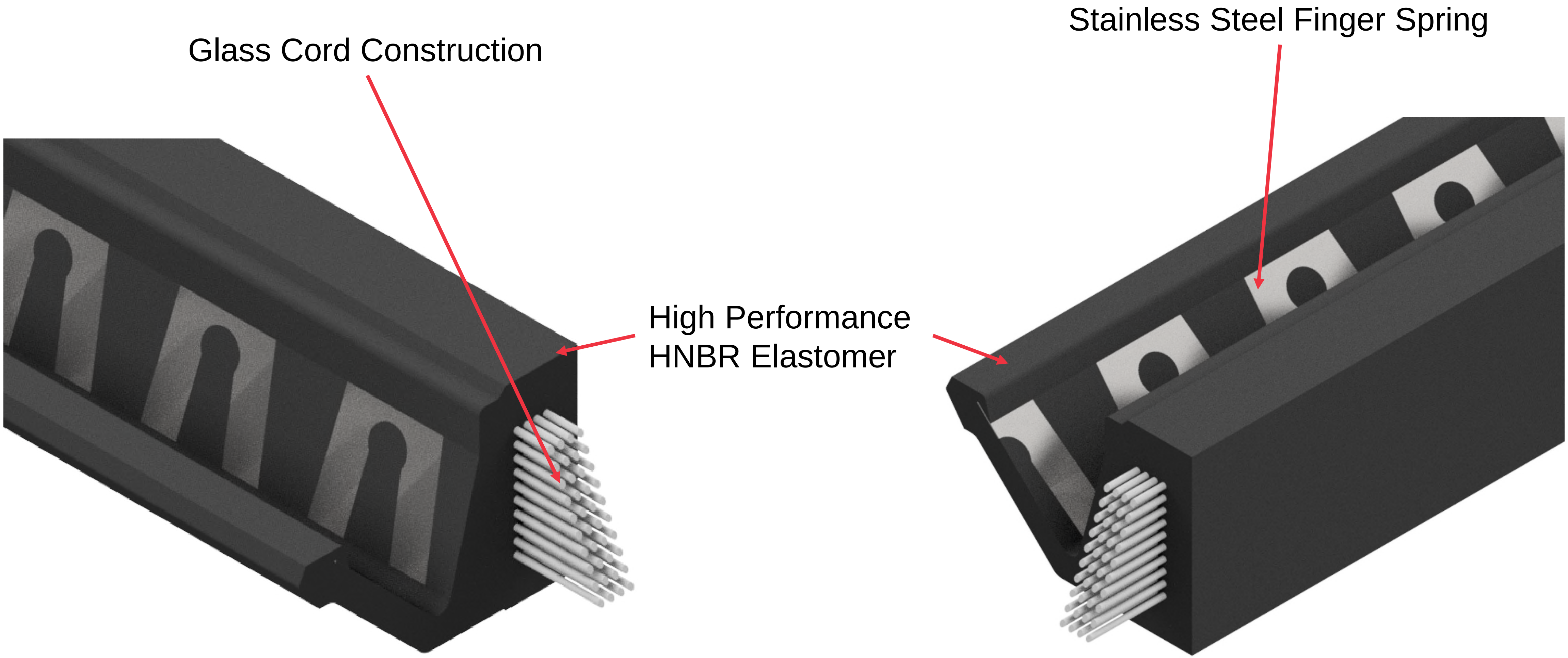




The main shaft bearings for direct drive wind turbines are usually moment bearings, typically double row tapered roller bearings or triple row roller bearings

- Continuously rotating, hub speeds of 5-15rpm
- Supports the weight of the hub and the blades.
- Under various wind conditions, the bearing can be subjected to large degrees of deformation
- Creates large deviations in the radial seal gap, as much as 4mm of deviation for a radial seal gap of 32mm
- Bearings are typically grease lubricated, with radial lip seals employed at both sides of the bearing
- Seal sizes in excess of 3m!

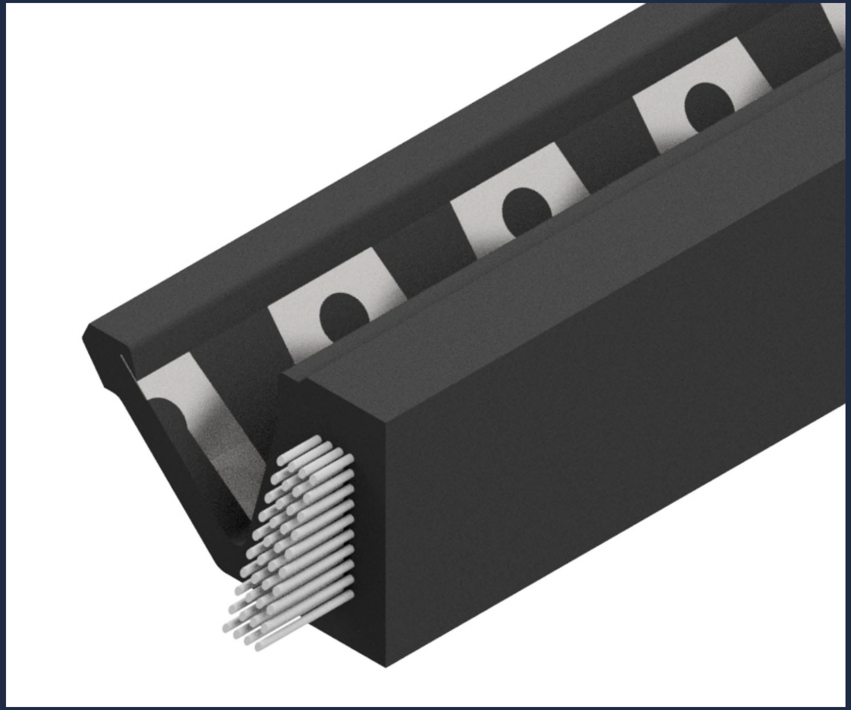
Walkersele X-Gen



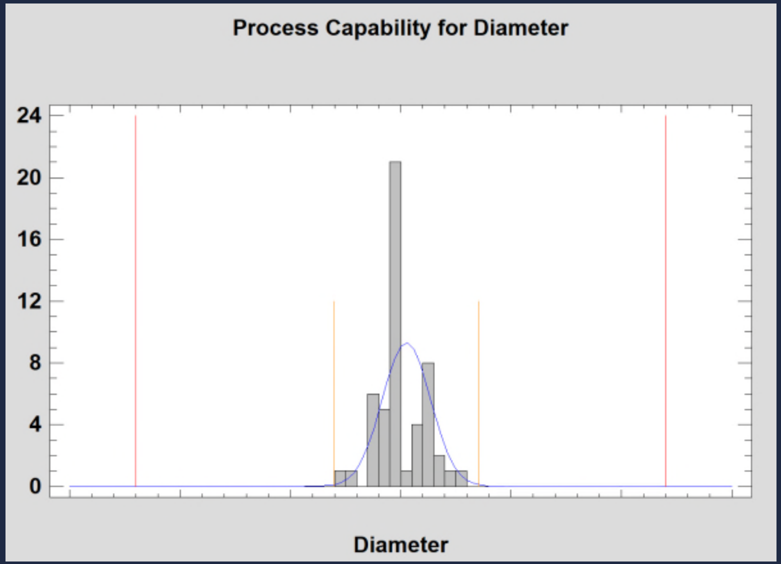
Patented Technology

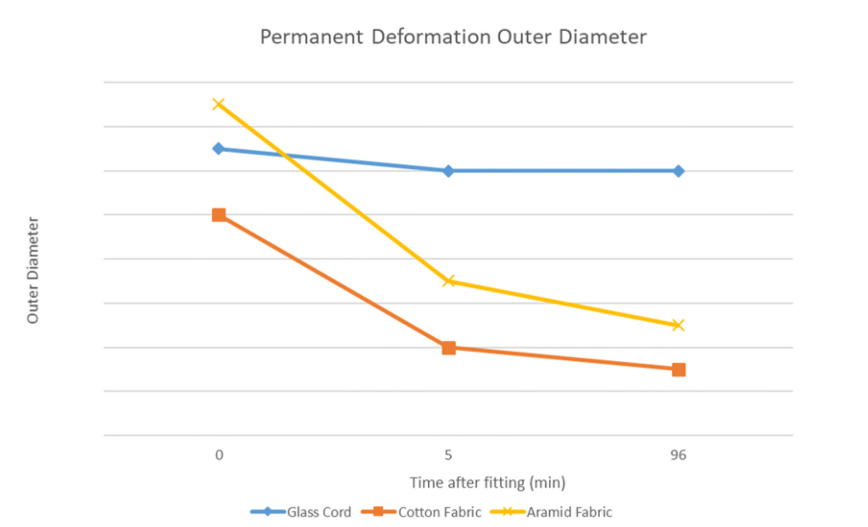
Why Glass?

- Maintain tight tolerances at large diameters
- Long term material recovery properties
- Improved joint integrity
- Sustainable manufacturing processes



Tighter Tolerances and Material Recovery





- Tighter tolerances compared to conventional products
- Significantly improved process capability when compared to conventional products

- Seals measured before fitting (t=0)
- Seals fitted to housings, and then removed to be measured at set intervals
- Glass cord shows minimal change to dimensions after fitting

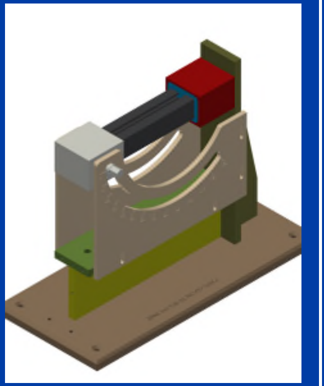
Improved Joint Integrity

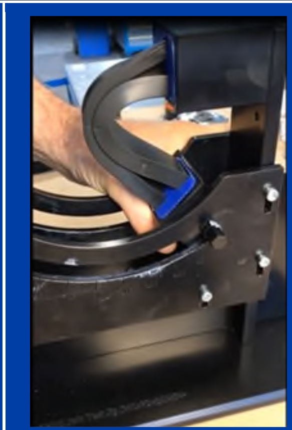
Seals for large diameters are manufactured using smaller rings which are split and joined to form the final size. The integrity of the join is therefore vital for a functioning seal.

Joins were sampled using the conventional joining method (Aramid Fibre) and the glass cord and the joins tested.

The testing was designed to mimic extreme handling of seals

Using 3 test configurations, which tested the join to destruction






Material	Angle of Twist	Bend Up	Bend Down
Glass Cord	Split observed at 540°	No Break Observed	No Break Observed
Aramid Fibre	Break observed at 270°	Break observed at 120°	Break observed at 110°

Sustainable Manufacturing Processes

Improved quality and efficiency, with the reliance on suppliers for coated fabrics reduced.

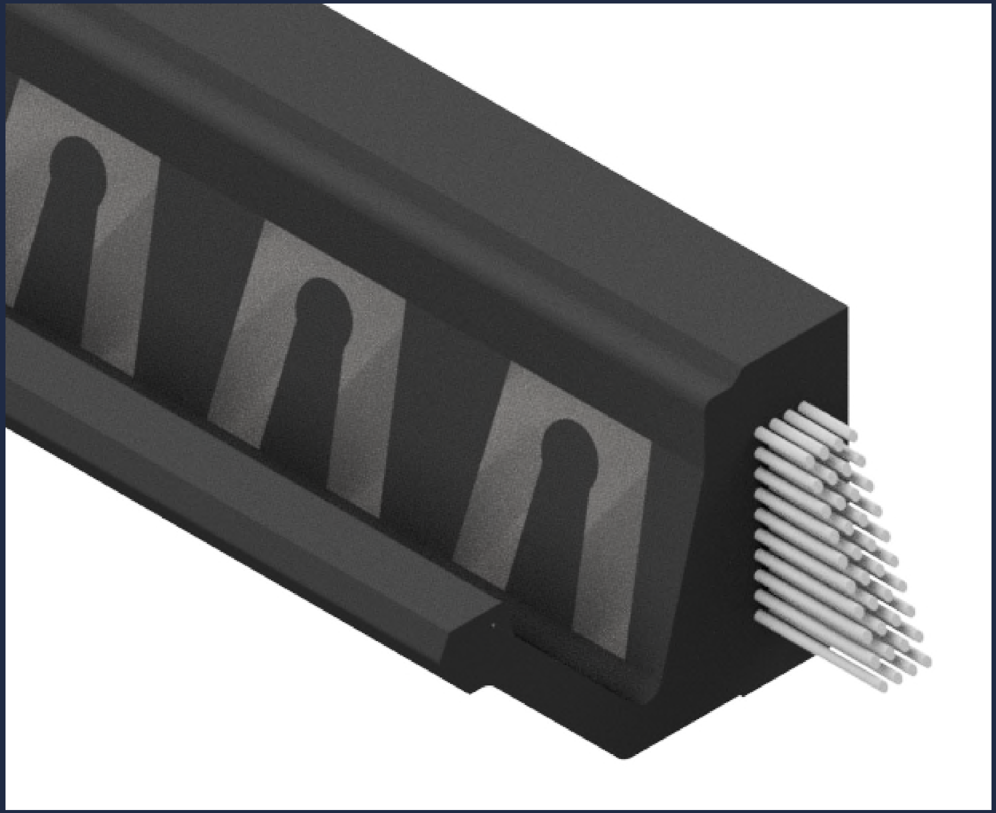
The improved joint integrity has also increased the efficiency of the joining process.

Removing coated fabrics has seen a 99% reduction in solvent use for this product line compared

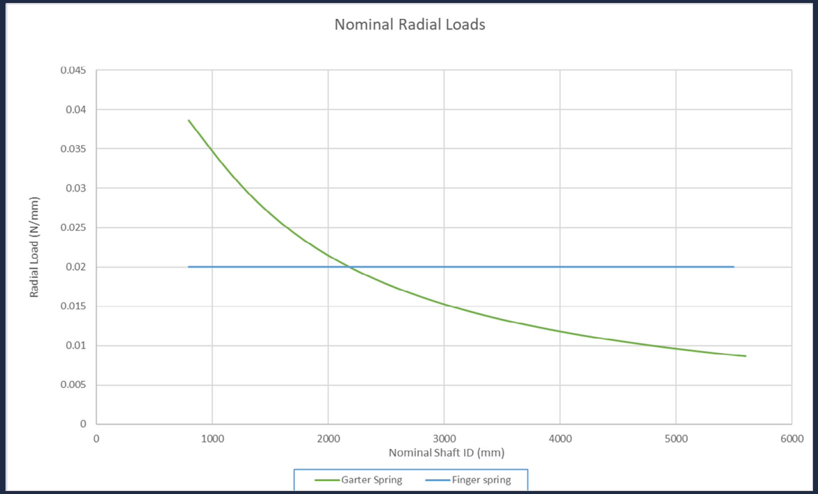
Reduced carbon footprint for raw materials by 94%

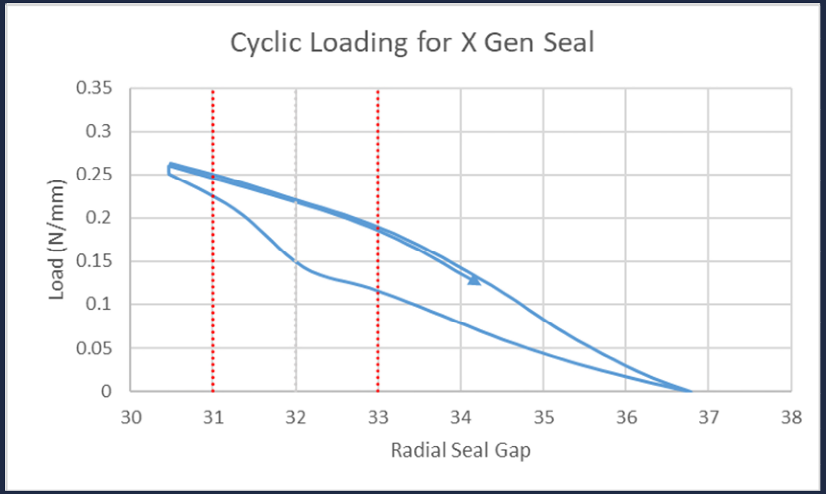
Why a Finger Spring?

- Consistent lip load for large diameter seals
- Superior eccentricity capability, response and fatigue resistance
- Enhanced spring retention
- Easier assembly



Independent & Consistent Loading





Garter springs become ineffective for this application at greater diameters

At nominal sealing gap, the radial load of the garter spring diminishes greatly

Garter springs are much more difficult to install effectively at these size ranges

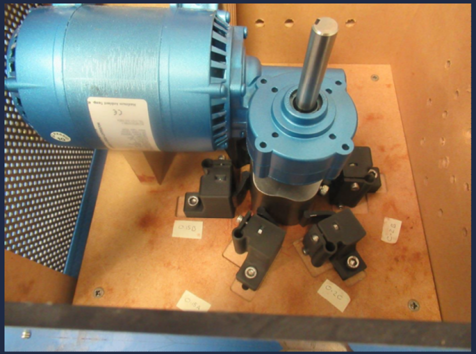
Spring fingers work independently, regardless of diameter

Consistent load across the lip travel ranges

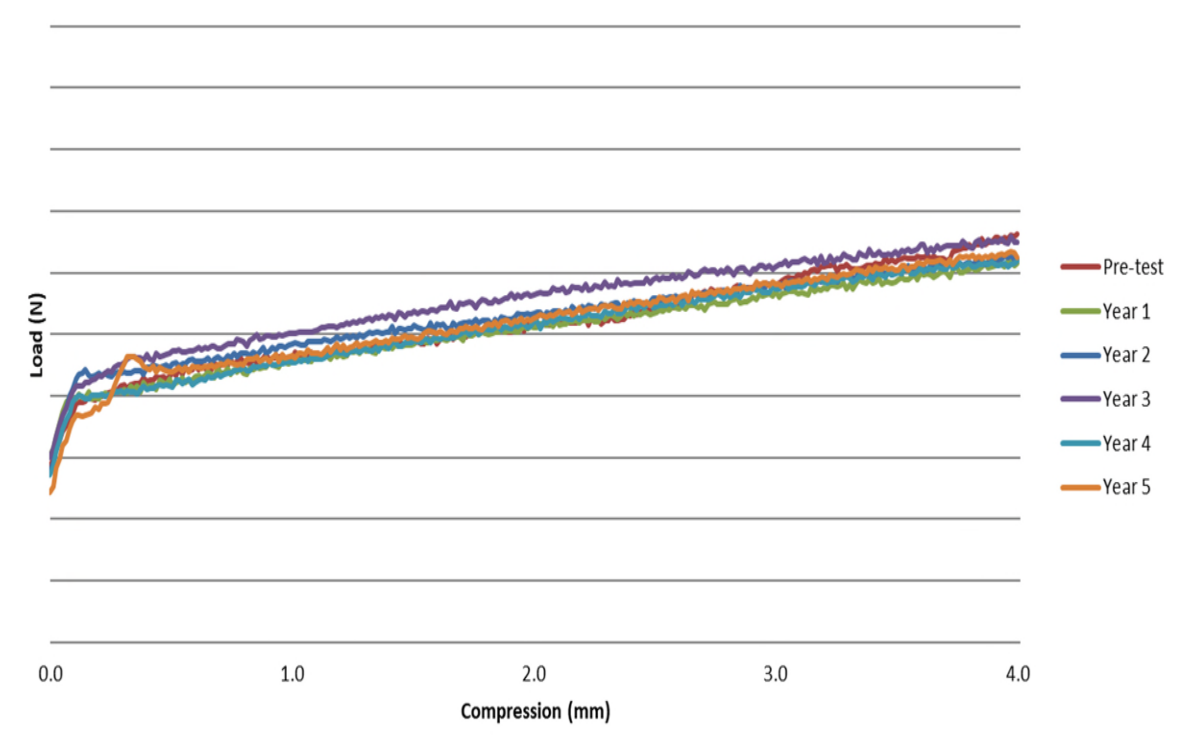
Load optimised to work well with grease

Speed of Response and Fatigue Testing

The seal and spring assembly was tested for its response and fatigue resistance. JW devised a test which tested sections of seal, with 6 Samples per test, to simulate long term running.



- 5 “lobed” cam to mimic maximum seal gap deviations
- 666 Hours equates to 5 years running
- Seal load measured at regular intervals



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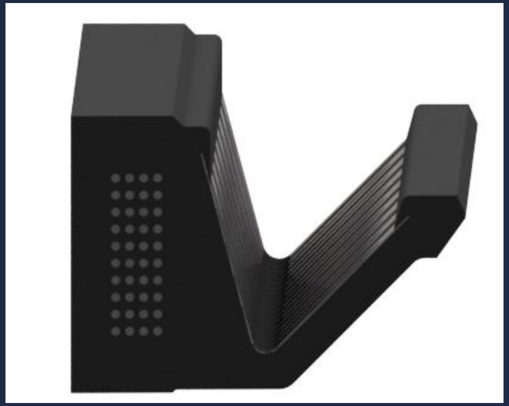
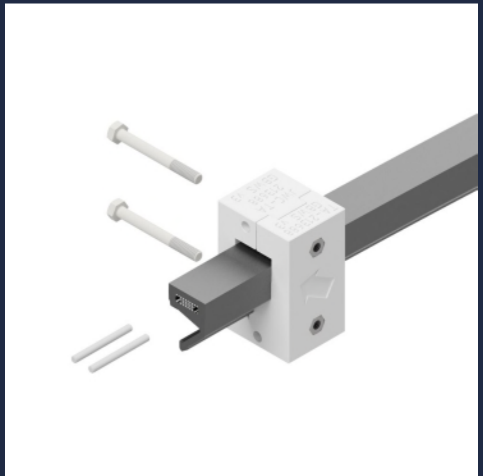
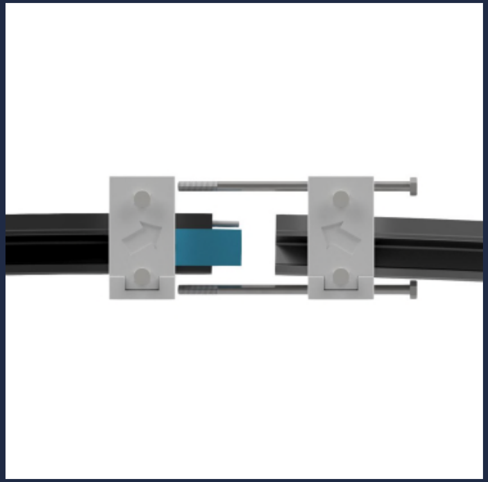
Enhanced Spring Retention and Easier Assembly







Springs are bonded in during moulding, seal is a delivered complete assembly. No more garter springs!

Spring ends are embedded in to the rubber, giving added assurance.

Spring is designed to allow for the seal to be coiled for transportation.

Compatible with onsite fitting in OSJ-D variant

Allows for seals to be fitted in the field with minimal equipment needed

Product Validation – Test Rig Development

Specifications

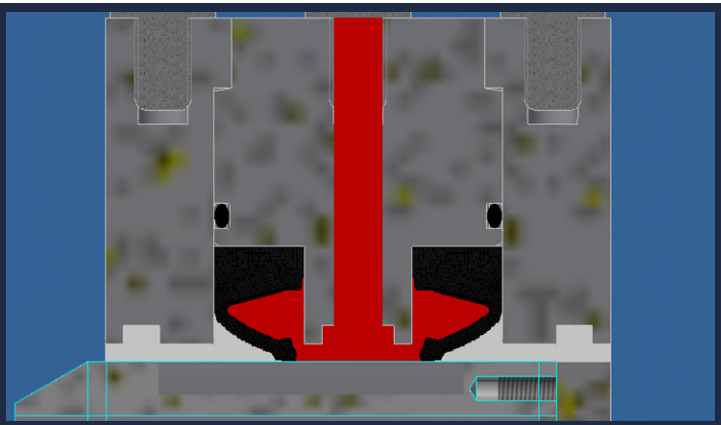
Nominal seal housing – ø1100 x ø1164 x 25mm

Eccentricity capacity – ±3.0mm

Lateral Offset – Housing can be repositioned laterally by ±5mm from concentric position

Seal housing can be tilted by up to 2°

Allows for continual measurement of torque, temperature, shaft speed and leakage.

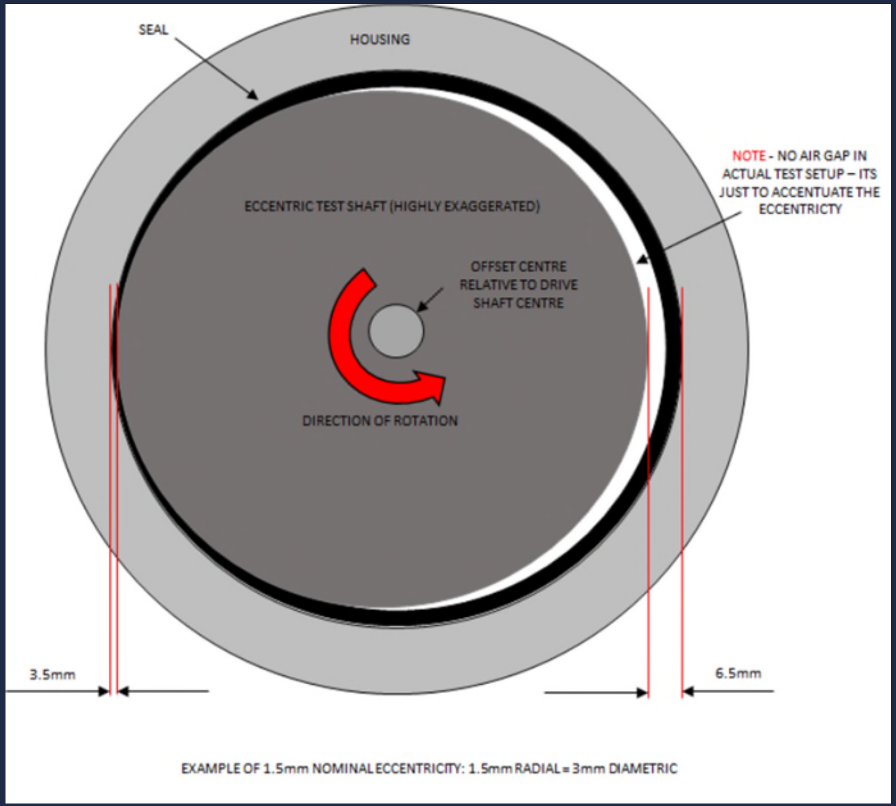


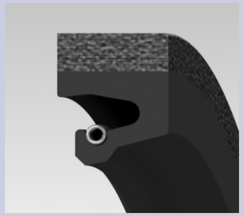
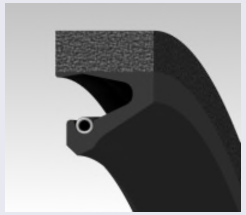
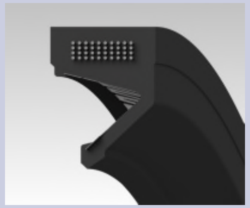
Uses of the Test Rig

Seal design validation

- Short term testing for capability, such as eccentricity range, break out torque, running torque, and leakage.
- Long term testing, looking at seal endurance, qualification and for validating process change acceptance.
- Flexible to meet customer specific testing needs i.e. alternative lubricants, specific seal developments, alternative materials etc.

Dynamic Eccentricity Ratings



	Design Reference	Max Permissable Eccentricity (mm)
	D6	±1.0
	D9	±1.5
	X Gen	±3.0

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Thank you for listening! Any questions?