TRELLEBORG

Over Bend Control Solutions

Bending Restrictors

To prevent pipes from overbending at the interface between flexible and rigid structures, Bending Restrictors are often installed

A Bending Restrictor (BR) usually comprises a number of interlocking elements which articulate when subjected to an external load and lock together to form a smooth curved "locking" radius. This radius is chosen to be equal to or greater than the minimum bend radius of the pipe that it is applied to. Once the elements have locked together the bending moment present is transferred into the elements and back through a specially designed steel interface structure into the adjacent rigid connection, therefore protecting the pipe from potentially damaging loads.

Flexible pipes, flowlines, power cables and umbilicals are usually connected to a rigid structure such as a subsea riser base, PLEM or wellhead. To prevent these pipes from overbending at the interface between flexible and rigid structures, Bending Restrictors are often installed on the pipe. The BR is specifically used where static or quasi-static loads act on a pipe, rather than dynamic loads when a Bending Stiffener would be more suited.

Advantages:

- A split design allows installation of the restrictor after pipe termination
- Ease of installation onshore and offshore
- Neutrally buoyant in water, eliminating self weight loading on pipe

We are able to offer either a bespoke design or make use of a vast array of existing designs of bending restrictor elements to suit a wide range of pipes, umbilicals and cables. We are also able to design and manufacture the steel interface structure required.

SHINYANG TECHNOLOGY co.,Ltd

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Design & Engineering

We work very closely with our clients to understand in detail a particular task or set of parameters under which the system will operate - handling, deployment, operation and recovery.

Our design and engineering team has significant technical knowledge and experience gained over many years in the offshore and oceanographic industries from design through to the installation of flexible pipelines.

We work very closely with our clients to understand in detail a particular task or set of parameters under which the system will operate - handling, deployment, operation and recovery.

The physical parameters are then converted into numerical data with the completion of a Design Data Sheet (DDS) - these are available from our sales department on request.

Important information required is:

- Minimum bend radius
- Pipe outside diameter
- Loads (bending moments, shear loads)
- Length of coverage
- Operating temperature

From this information our engineers can either select a suitable existing design of Bending Restrictor element, or use an in-house software design tool - RESTRICTOR to design a bespoke element, which complies with both the geometrical and loading requirements specified by the client.

Having understood the application and mechanical interfacing requirements to satisfy the specification, the Restrictor is designed to meet in service conditions in the most cost effective way.

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Interface Structure

Once the Bending Restrictor elements have been designed/selected it is necessary to design a suitable steel structure to attach the elements to the adjacent rigid connections.

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This often requires complex interface engineering with the pipe/umbilical supplier, subsea equipment designers and installation contractors all wishing to have an input into the design process to ensure ease of construction, installation and integrity in service.

The interface structure comprises a split steel component which has a housing which fits around the 'heel' end of the Bending Restrictor element, and then bolts or clamps to the adjacent structure. This is a 'female' connection and is suitable for applications where the Bending Restrictor is fitted to the pipe at the 'second end-off' the reel.

Alternatively, a 'male' connection can be used where the Bending Restrictor elements fit over the steelwork - this is suitable for 'first end-off' applications.

Either the male or female connections can be attached to the adjacent rigid structure by two main methods:

- Reaction flange
- Reaction Collar

The reaction flange has a simple split flange arrangement which bolts directly onto the adjacent structure, whereas the reaction collar is a split shell configuration which clamps around the keys into the pipe end fitting/termination head.

We also have experience of designing and building additional adapter flanges, extension spools and pull-in connectors which may be required for particular applications.

All design is conducted in accordance with the relevant codes and specifications (e.g. NORSOK, DNV, API etc.) and fabrication is conducted in accordance with approved weld documentation and fully qualified welders using ASME IX (or equivalent) procedures.

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Materials

The polyurethane elements are usually molded yellow or alternatively orange. Both colors provide excellent visibility when the restrictors are subsea.

The following materials are used in the manufacture of bending restrictor components:

Elements - structural polyurethane

Elements fasteners - super duplex stainless steel

Interface steelwork - high strength structured steel

As the polyurethane elements and super duplex fasteners are inert/corrosion resistant in seawater, the only part of the structure requiring corrosion protection is the interface steelwork. This is usually provided by a suitable subsea coating system (e.g. NORSOK, System 7) and either connection to an adjacent cathodic protection system or by attachment of its own dedicated anodes.

For particular high temperature applications (i.e. production flowlines) the use of titanium or Alloy 625 Element fasteners may be considered.

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Typical material properties of polyurethane used to manufacture bending restrictor elements are outlined below:

TYPICAL PHYSICAL PROPERTIES AT 23°C

Property	Test Method	Value	Unit
Shore Hardness	BS 2782 Pt 3	80	°D
Tensile Strength	BS 903 Pt A2	45	MN/m^2
Elongation at Break	BS 903 Pt A2	20	%
Heat Distortion Temperature	BS 2782 Pt 1	70	°C
Izod Impact Strength (Notched)	BS 2782 Pt 3	8	KJ/m^2
Specific Gravity - cured		1.150	kg/m^3

All values are typical

TYPICAL PHYSICAL PROPERTIES AT 60°C

Property	Test Method	Value	Unit
Shore Hardness	BS 2782 Pt 3	74	°D
Tensile Strength	BS 903 Pt A2	21	MN/m^2
Elongation at Break	BS 903 Pt A2	64	%
Heat Distortion Temperature	BS 2782 Pt 1	70	°C
Izod Impact Strength (Notched)	BS 2782 Pt 3	13	KJ/m^2
Specific Gravity - cured		1.150	kg/m^3

All values are typical

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Manufacture

The moldings are manufactured by injecting liquid polyurethane into a mold tool which then solidifies and is demolded prior to being oven cured.

We make use of modern, state-of-the-art production techniques and our many years of experience processing polyurethanes to manufacture high quality Bending Restrictor element moldings.

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The mold tool which is utilized is of critical importance to the final product quality and is precision machined from aluminium castings to meet very tightly controlled dimensional tolerances.

The tool's modular configuration allows easy change-out of parts which allows quick and cost effective modification of existing designs to suit a new application. The tool is usually mounted in a large semi automated hydraulic press, which significantly improves the turnaround time for manufacture of moldings.

Our experience of processing large volumes of polyurethane, whilst maintaining the strictest of quality control procedures is second to none. Large investments in modern, efficient dispensing equipment and storage tanks has made this possible, which together with round the clock shift working means that short lead times are possible to suit the most pressing of client requirements.

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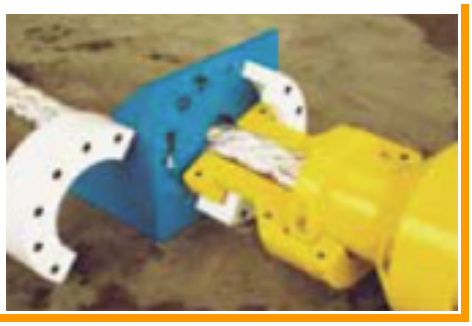

Testing

We have a modern and well equipped QA/QC laboratory which allows most material testing (tensile, compressive etc) to be conducted in-house

Factory acceptance testing of bending restrictors can be divided into three main categories:

Materials testing

Fit-up, assembly testing

Load testing

Materials Testing

Stringent quality control checks are carried out on all batches of polyurethane material used in the manufacture of Bending Restrictors. This includes both good-inwards and in-process checks to ensure that only raw materials with the correct material properties are put into production and that these properties remain consistent throughout the manufacturing process.

We have a modern and well equipped QA/QC laboratory which allows most material testing (tensile, compressive etc) to be conducted in-house. Alternatively if Third Party Approval test results are required, we have free access to a local NAMAS Approved Test House.

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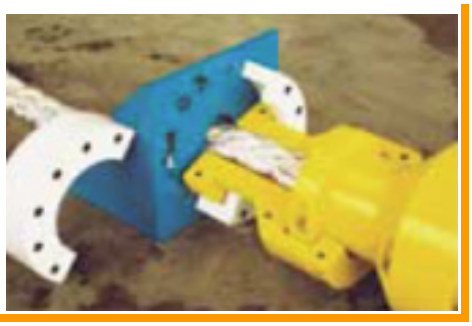

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Fit-Up and Assembly Testing

Generally when a client opens the packing case for the first time, he will be offshore on an installation vessel. It is therefore vital that in order to prevent expensive delays, all the components of the Bending Restrictor fit-up and assemble together as requested.

As a matter of routine, the Bending Restrictor elements will be fully assembled in a string using the correct fasteners prior to release for dispatch from us.

In addition, the elements will be assembled onto the particular interface steelwork component, which in turn will be fitted up to either the real or a mock-up of the rigid interface structure.

Load Testing

To ensure that the Bending Restrictor has a suitable load capacity, many clients specify that a load test is undertaken. Two types of load test can be conducted:

- Proof load testing
- Destructive load testing

With the proof load test, a fully assembled string of elements is subjected to the calculated maximum in service loading. The load is held for a defined time period and the restrictor is then examined for any signs of damage.

If a destructive load test is specified, the Restrictor is first proof load tested then the load is increased until failure of one or more of the elements occurs. The failure load is recorded and compared to the load anticipated by calculation methods.

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