Managing Marine Growth for VIV Suppression Devices

Most tubulars in the ocean experience marine growth near the surface of the water column extending to a depth of about 200 meters. This can cause significant performance degradation of the attached VIV suppression devices. Fortunately, the application of various anti-fouling coatings prior to installation and/or subsea cleaning operations can significantly extend the lifetime of suppression devices under such conditions.

Marine growth can begin forming on a marine tubular in just a few hours after installation. After a few months, the suppression device may become unrecognizable as large soft growth overwhelms its contours. Helical strake fins can effectively be negated while fairings become oval-shaped clumps of marine growth that no longer streamline the flow. Fairings can also have trouble weathervaning with changes in current direction. Even with small levels marine growth, the performance of VIV suppression can be drastically reduced.

To accurately evaluate the effects of marine growth on tubulars, VIV Solutions team members performed VIV tests on flexible cylinder models with various levels of marine growth using several test setups. For fouled bare tubulars in the critical Reynolds number range applicable to most production tubulars, increases in surface roughness generally resulted only small changes in vibration amplitude and drag. The figure below is a comparison of drag coefficients for bare tubulars of different roughness values.

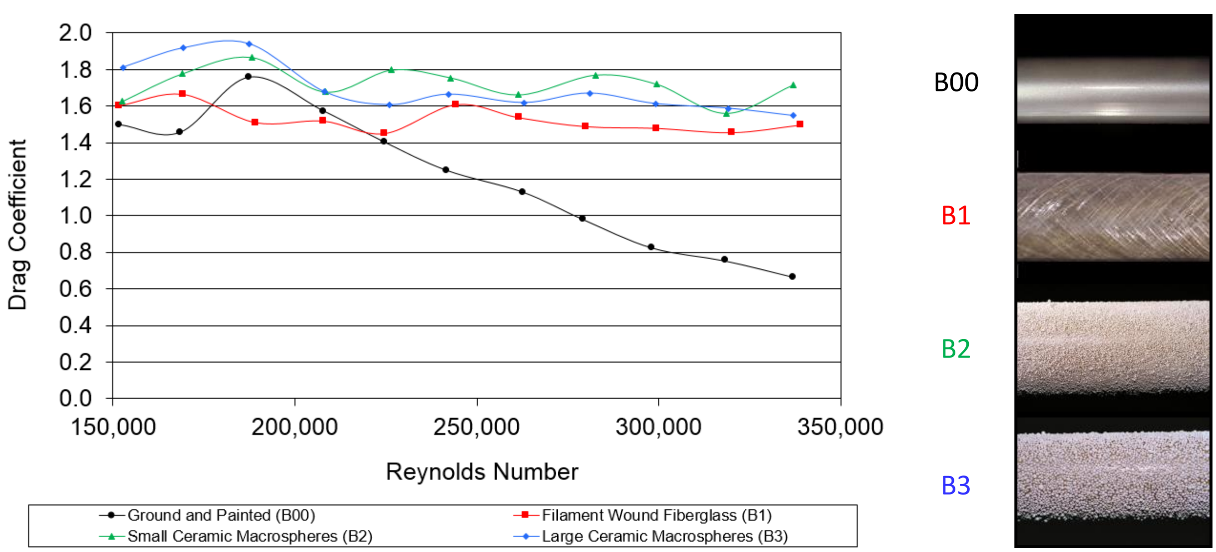

Figure 1 – Bare Cylinder Drag Coefficients with Varying Levels of Surface Roughness

The smooth ground and painted cylinder (B00) experienced low drag in the critical Reynolds number range while the rougher cylinders (B1, B2, and B3 which had relatively small levels of surface roughness) experienced higher drag that was relatively insensitive to Reynolds number. It should be noted that the small macrospheres produced slightly lower drag than the large macrospheres but the vibration with the large macrospheres was lower than that for the small macrospheres too, thus the drag differences between these two cylinders is most likely due to the lower vibration. The exception was very smooth cylinders which experience low drag and vibration in the critical Reynolds number range.

Large macrospheres were also used to evaluate the performance of tandem helical strakes with fins that were epoxied to the bare cylinder surface. The ends of the cylinders were spaced 20D apart (where D is the diameter of the test cylinder). The test conditions included large macrospheres completely covering the strakes, large macrospheres adhered to the fins only (by filing off the macrospheres on the base area of the test cylinder), large macrospheres completely filed off the fins and the test cylinder, and a test cylinder that was painted after the macrospheres were completely filed off. The two photographs below show the test cylinder after the macrospheres were filed off but left on the fins and the test cylinder after the macrospheres were completely filed off and the test cylinder was then painted. These photographs are followed by plots of the test results for the upstream and downstream cylinders, respectively. Accelerations were chosen because they most closely represent bending stress and incorporate both displacement and response frequency information.

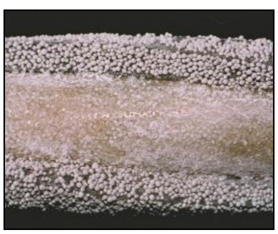

Figure 2 – Large Macrospheres on Fins Only

Figure 3 – Large Macrospheres Painted After Filing Off

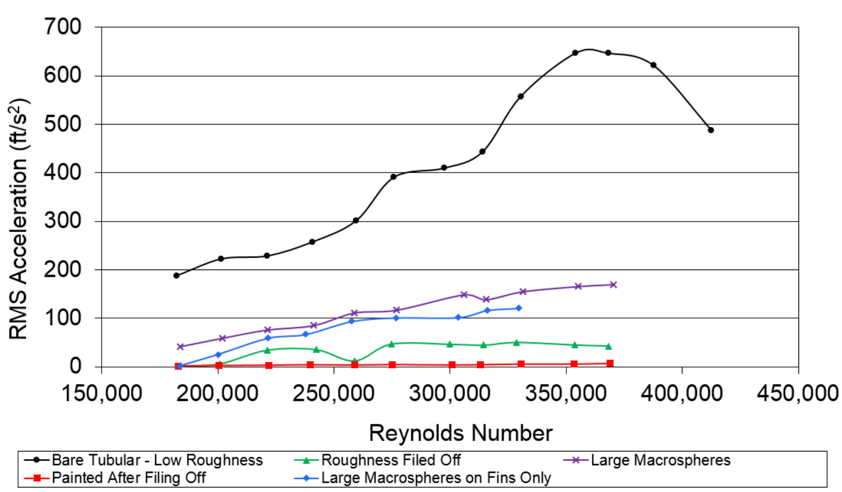

Figure 4 – Upstream Tubular Accelerations for Helical Strakes with Simulated Hard Growth

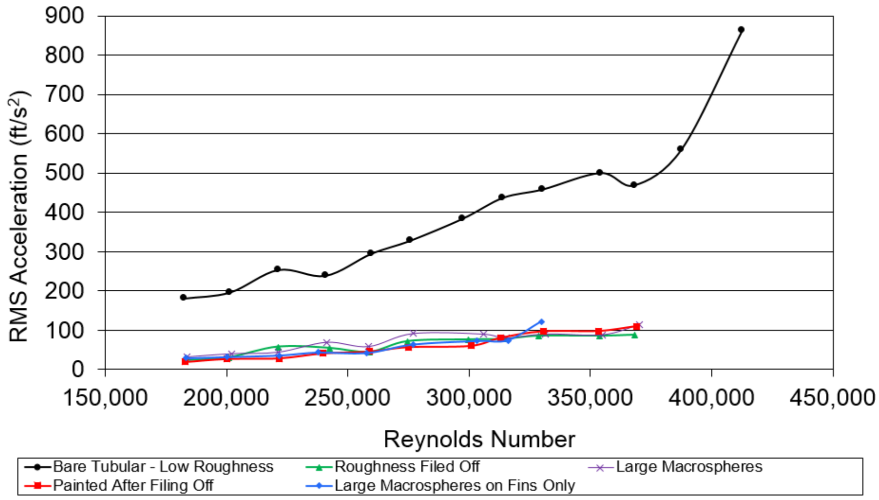

Figure 5 – Downstream Tubular Accelerations for Helical Strakes with Simulated Hard Growth

As expected, the upstream cylinder experienced accelerations that increased as the surface roughness increased. While there was a clear advantage for the smooth helical strakes (the test cylinder that was painted after filing off the macrospheres), it is encouraging that the strakes still significantly reduced vibration even with the hard macrospheres present. Similar results have been found when simulating low levels of soft marine growth on helical strakes. It is important to note that tests by other researchers have shown very strong degradation in the strake performance when the marine growth is larger than what was tested here.

The downstream cylinder experienced accelerations that were almost identical regardless of the marine growth level on the test cylinders and strake fins (both the upstream and downstream test cylinders had identical simulated marine growth for all of the tests). This interesting result indicates that the wake formed by the upstream tubular may be fairly similar regardless of what level of roughness is on the helical strakes.

Similar tandem tests using the large macrospheres were also conducted on cylinders equipped with fairings. These fairings closely resembled VIV Solutions' standard teardrop-shaped fairings and were free to weathervane with changes in the current direction. A photograph of the fairings with simulated marine growth is shown below.

Figure 6 – Large Macrospheres on Fairings (Rough Fairings)

Test results for a 20D spacing between the ends of the test cylinders indicate that the macrospheres caused a small degradation in the performance of the fairings; however, the fairings were still very effective at suppressing VIV on both cylinders even with the large macrospheres present.

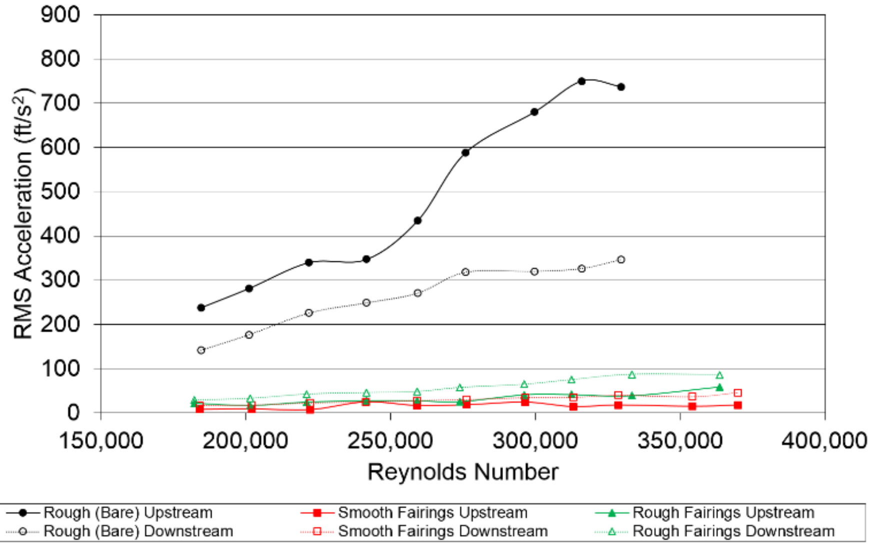

Figure 7 –Tubular Accelerations for Fairings with Simulated Hard Growth (20D Spacing)

When the end spacing was decreased to 5D, the degradation in the fairing performance was more pronounced as can be seen in the figure below.

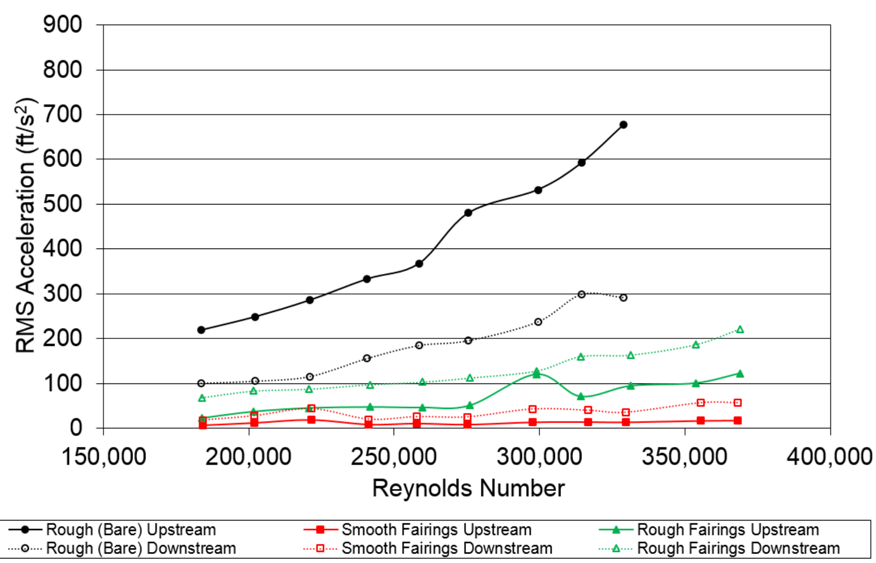

Figure 8 –Tubular Accelerations for Fairings with Simulated Hard Growth (5D Spacing)

The performance degradation is larger even for the upstream cylinder. However it should be noted that, while the distance between the cylinders at the ends is 5D, the fact that the cylinders are flexible means that the distance between them can be much smaller than 5D at the two ends. Similarly, increased degradation was observed for helical strakes. In general, if adjacent tubulars are allowed to come into close proximity, the suppression devices should be kept relatively clean.

There are a number of products that can be applied to the surface of suppression devices to delay the formation of marine growth. For helical strakes, an anti-fouling coating is often painted onto the exterior of the device and then these strakes are installed in the top 200 meters of the water column. All anti-fouling coating options are fairly expensive (often more expensive than the strake body itself) and each have their shortcomings. Even the more expensive copper-based coatings can fail completely if a green slime layer forms on their surface and prevents further leeching of the cuprous oxide.

For fairings, it is common to use copper bar on the inside of the fairing body to prevent marine growth from forming in the annulus and to use copper bar on the upper and lower surfaces of thrust collars to keep the bearing surfaces clean. These two anti-fouling measures have a strong historical success rate and allow fairings to continue weathervaning for many years with changes in current direction.

When it is not possible to pre-install anti-fouling measures on a suppression device or when a coating has reached the end of its lifetime, one may consider cleaning the exterior surfaces via waterblasting with a subsea ROV. Cleaning can be expensive but costs can be minimized with forethought during the platform and tubular design phase. For most tubulars, a pre-installed anti-fouling method, coupled with further inspection surveys and subsea cleaning programs, can improve the longevity of VIV suppression devices located in high marine growth areas.

VIV Solutions' helical strake and fairing products are well tested and field proven for over two decades. They have been installed on scores of tubulars, providing reliable performance and superior suppression efficiency in regions experiencing both hard and soft marine growth.

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