# Fairing Shape: The Pros and Cons of Popular Fairing Geometries

*Fairings have been studied since the early days of airfoils and boat keels, yet their optimal profile remains elusive. Various shapes have been used to suppress VIV in deepwater while providing lower drag. Each has its own benefits.*

Fairings have the distinction in that they can reduce both drag and vortex-induced vibration (VIV), unlike helical strakes which reduce VIV but usually cause increase the drag relative to that of a bare tubular. However, not all fairing shapes are effective, and there is a significant amount of science around designing a fairing for a specific application.

Some of the terminology associated with fairings is shown below.

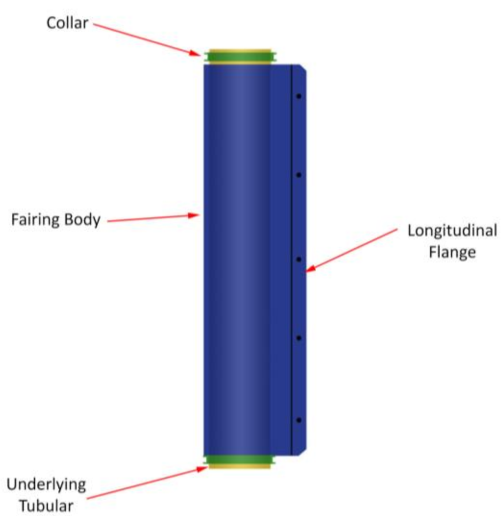


**Figure 1 – Fairing Side View**

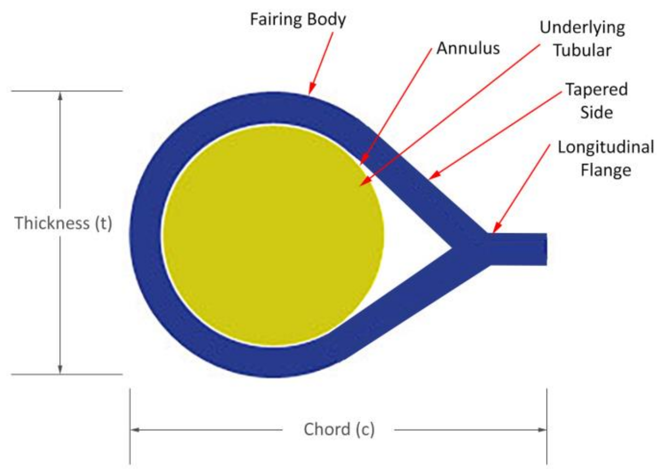


**Figure 2 – Fairing Top View**

## Fairing Shapes

The task of developing a fairing is a combination of both art and science. This has resulted in numerous interesting and creative fairing shapes that have been tested and used over the past 40-50 years. Most early fairings were long chord fairings with a chord-to-thickness (c/t) ratio of about 2 or more. Many of these long chord fairings had a stabilizer fin at the tail to keep them aligned with the flow and prevent fairing flutter, which is a pitch-torsional instability that can result in large tubular motions. Today the most common shape is a teardrop shape having a relatively short chord with sides that converge to a narrow tail. Another profile that has gained some popularity is the U-shape fairing which has sides that are parallel or taper inward (but to a lesser extent relative to teardrop shaped fairings). These fairing shapes are illustrated in the figure below.

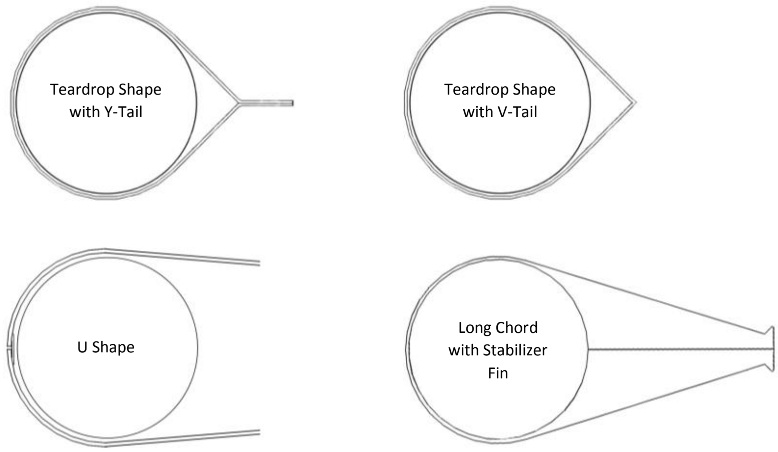


**Figure 3 – Sample Fairing Shapes**

Teardrop fairings can have a Y-shaped tail or a V-shaped tail. This fairing shape was discovered in the late 1980s by two VIV Solutions staff members and has been in active use since the mid-1990s.[1] Teardrop fairings with Y-shaped tails are used extensively on various tubulars including drilling risers, production risers, tendons, umbilicals, and pipeline spans. The vast majority of fairings on deepwater tubulars are teardrop fairings with Y-shaped tails.

The teardrop fairing is characterized by sides that converge towards a narrow width or a "point." For Y-shaped fairings there is a flange past that point; for V-shaped fairings the tail ends at the point. The V-shaped fairing was tested and built many years ago by VIV Solutions staff and, like the Y-shaped fairing, found to be effective at high Reynolds numbers. It has been successfully used on a drilling riser as a Tail Fairing™ in very high currents.[2]

Another profile is a U-shaped fairing which is a much newer design than the teardrops but has seen a modest level of use in the field.[3] The nose of this fairing is rounded, and it has two sides that extend downstream with the sides being parallel or converging slightly towards each other. It has various trade names associated with it. VIV Solutions has its own patented U-shape fairing which has an opening at the nose for fast and easy installation, along with other U-shape designs.

Fairings are often distinguished by their chord-to-thickness (c/t) ratio. The chord is measured from the fairing nose to the far end of the tail flange (or the furthest aft point of the fairing body) while the thickness is the widest dimension across the fairing, usually measured at a point approximately 90 degrees from the nose.

While fairings with short c/t ratios are most by far the most popular, longer chord fairings can also be used. Longer chord fairings can be teardrop shaped or have a blunt tail. Often longer chord fairings with a blunt tail will have a stabilizer fin attached. Longer chord fairings were pioneered in the mid to late 1970s by several companies[4,5] with c/t ratios ranging from 2.1 to 2.5, many of which encompassed a stabilizer fin. Experiences with longer chord fairings in the field have been positive, though more recent testing has found that some longer chord fairings can experience an instability called "flutter" in the laboratory.[6] To our knowledge, fairing flutter has never been observed on an actual riser in the field.

**VIV Suppression and Drag Performance**

All fairing shapes are dependent upon various design parameters. If these design parameters are correct, then the fairing can suppress VIV very effectively. Optimal fairing performance is achieved by streamlining the oncoming flow so that the separation points are downstream of the underlying tubular body. This causes a good portion of the vortex formation to occur downstream of both the fairing and the tubular body so that the forces on the tubular itself are minimized. Beyond this description, the vortex shedding for the various fairing types is different.

The objective of a teardrop fairing is to streamline the flow as far along the tapered section towards the tail flange as possible. The taper angle, taper length, flange thickness, and flange length can all be varied for a given application. These parameters also determine the fairing's chord-to-thickness ratio.

Teardrop fairings have an advantage over the other fairing shapes in that, if properly designed, they allow the separation points to be closer together so that the width of the wake is minimized. Y-shaped tails also feature a flange to further separate the vortices on both sides of the fairing, which acts as a miniature splitter plate for small vortices that form on the tapered sections of the fairing. The narrower wake from teardrop fairings results in higher pressures in the wake, thus teardrop fairings generally have significantly lower drag than U-shaped fairings. It is interesting to note that one particular fairing test program with an improperly designed teardrop shape still experienced drag coefficients that were about 15 percent lower than identical tests for U-shaped fairings.[7]

Teardrop fairings can be challenging to design due to their short c/t ratio, resulting in an inefficient fairing that fails to decrease drag. It is important to properly engineer all the relevant parameters that can affect their performance. Some tank tests have found less than stellar performance from teardrop shaped fairings due to improper understanding of how they should be designed. Fortunately, the track record for field use of teardrop fairings is excellent. They have been used on over 100 tubulars worldwide, with some tubulars having teardrop fairings in place for over 20 years without issue (most of these were designed by knowledgeable VIV Solutions personnel). Thus, it is important that the provider of teardrop fairings has the necessary experience to design them correctly.

U-shape fairings function somewhat differently than teardrop fairings in that the separation points are kept further apart since the sides of a U-shaped fairing are parallel or taper inward only slightly. This produces a wider wake and therefore also results in higher drag relative to Y-shaped or V-shaped fairings. The advantage of U-shaped fairings is that they can be less sensitive to geometric variations and thus are simpler understand and fabricate. U-shaped fairings sometimes have flanges at each end to reduce spanwise correlation of vortex shedding that can occur due to the wide wake.

Fairings with long c/t ratios must be carefully designed but have the potential to produce very low drag coefficients coupled with high VIV suppression effectiveness.[8, 9] The drag coefficients associated with long c/t ratio fairings are often one-half to two-thirds the drag coefficients associated with shorter c/t fairings. While the potential for flutter must be carefully considered, long c/t fairings can provide the best combination of VIV suppression and low drag. Long c/t fairings can be quite expensive however, with costs far exceeding that of shorter c/t fairings.

Thrust collars are utilized for all of the fairing shapes to maintain axial position along a tubular, but these collars can also serve a dual purpose for reducing spanwise correlation of vortices, even if the separation points are close to the fairing tail. Collars can both positively and negatively impact fairing performance. It is important to understand the effect of collars when designing the complete VIV suppression system.

## Fairings for Deepwater Drilling

A special type of fairing that is often used for drilling risers is called a Tail Fairing™. Tail Fairings consist of a fairing tail and one or more straps as shown below to minimize installation time in the moonpool.

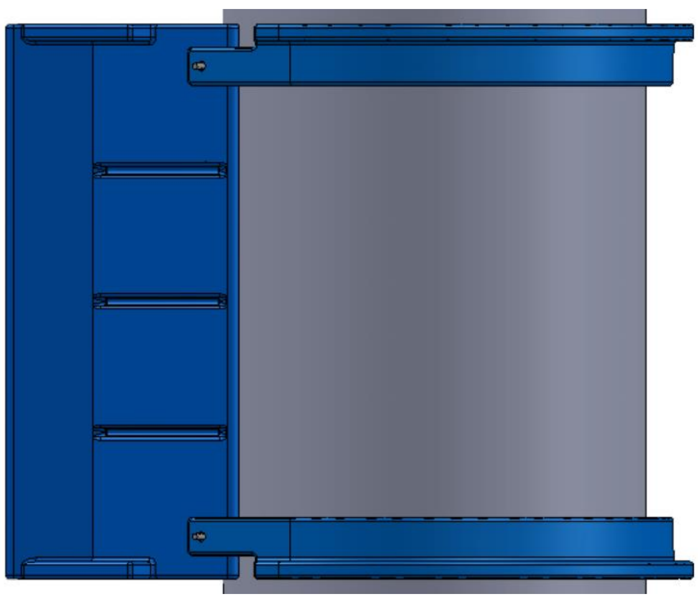

**Figure 4 – Tail Fairing for Deepwater Drilling**

Drilling riser fairings can be manufactured as teardrop or U-shaped, with Y-shaped teardrop Tail Fairings being the most popular. Tail Fairings have an excellent performance track record with use on numerous drilling rigs over a period of almost two decades.

## Conclusions

In summary, teardrop fairings remain the most popular fairing shape in use but U-shaped fairings have seen use in recent years. The advantage of teardrop shaped fairings over U-shaped fairings is their potential to produce lower drag, while U-shaped fairings have the advantage of being a little less sensitive to some design parameters. V-shaped fairings can be very useful at very high Reynolds numbers and rival (perhaps even slightly exceed) the performance of Y-shaped fairings but they do not have the track record that Y-shaped fairings have. Regardless of which fairing shape is chosen, it is important to have a robust design proven through extensive hydrodynamic testing and/or field use. VIV Solutions can customize fairing geometries to optimize drag and suppression efficiency per the customer's requirements.

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