Wedge Wire vs. Profile Bar for Flat Screen Applications

Wedge wire, also known as profile wire or V-wire, is the basis of Elgin's screening products. Unlike perforated plate or woven wire, wedge wire screens offer a 2-point particle contact and slot openings that widen in the direction of flow so that particles are less likely to plug the screen.

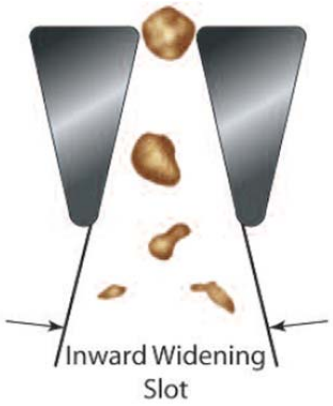

Figure 1: Wedge Wire Particle Exclusion

Elgin's historical customer base is the coal and mining industry. Wedge wire screens are used to dewater and separate various aggregates. Most often these screens are used within a vibrating or centrifugal environment, seeing excessive acceleration of large particles normal to the surface and various frequencies of vibration.

As a result of this excessive abuse, Elgin manufactures wedge wire screens using TIG welding. When compared to resistance welding, TIG welding offers a much stronger bond. This stronger bond is the result of a hotter, slower welding process that yields deeper mixing of the metals (see figures 2 and 3). Elgin screens are welded in a flat orientation as opposed to resistance welded screens that are typically welded in a cylinder. To produce a flat screen the cylinder is then cut and rolled flat, exposing the welds to additional stress, resulting in an even weaker final product. For cylindrical screens that are exposed to radial compression this weld strength is less critical, but for flat panel screens this difference is significant.

This difference drove Elgin's competition to create assembled screens using a taller profile bar with a U-clip and pin system. This profile bar creates a taller wire structure that minimizes the underneath support needed. The lack of welding in the system also results in a cleaner looking screen final product, which is important for the aesthetic needs of the architectural screen market. The final assembly is also able to hold very tight flatness tolerances due to the lack of heat introduced during welding.

Although profile bar has some advantages, for the purposes of a water intake screen the advantages don't warrant the excessive price of profile bar. The following sections compare wedge wire screens and profile bar screens with respect to strength, flatness and price.

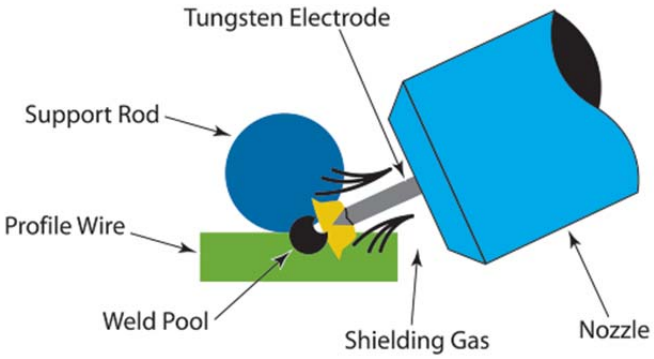

Figure 2: TIG Welding Process

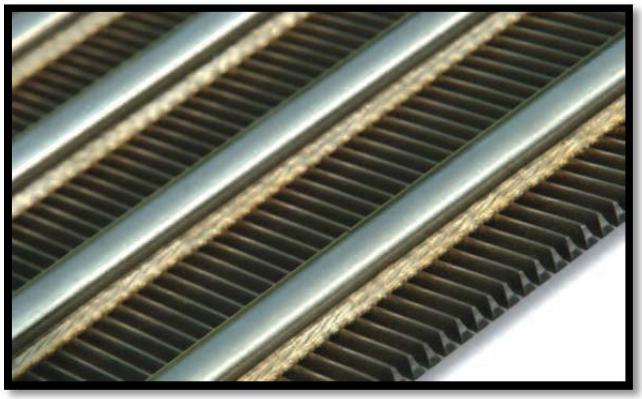

Figure 3: TIG Welding Final Product

Strength

A common argument for using profile bar is that it's stronger. If profile bar and wedge wire were supplied in free space without any supporting elements, of course profile bar is stronger than wedge wire. The design intent of profile bar is to provide nearly all of the support using the bar itself. The wedge wire screen has essentially the same profile at the top area, but the difference is that it is welded to support bars.

Figures 4 and 5 reflect screen panels that have equivalent strength (equivalent screen wire width and porosity with same deflection over a 12 in span). To achieve the same strength, the welded wedge wire panel can simply weld to ¼ in stock bars that are ¾ in tall on 3 in centers. This is a very typical support bar spacing used in TIG welding, so meeting the requirement is nothing out of the norm for Elgin's process. If higher strength is needed in one direction more than the other (longer span needed in either direction), a TIG welded panel can exchange the larger ¼ in bar stock for smaller welding bars (round rods) and add a layer of support bars going perpendicular to the welding bars. A profile bar screen panel will be limited in the spans that can be achieved with the base assembly – ultimately support bars will need to be welded to the screen, resulting in the same type of structure as a wedge wire screen.

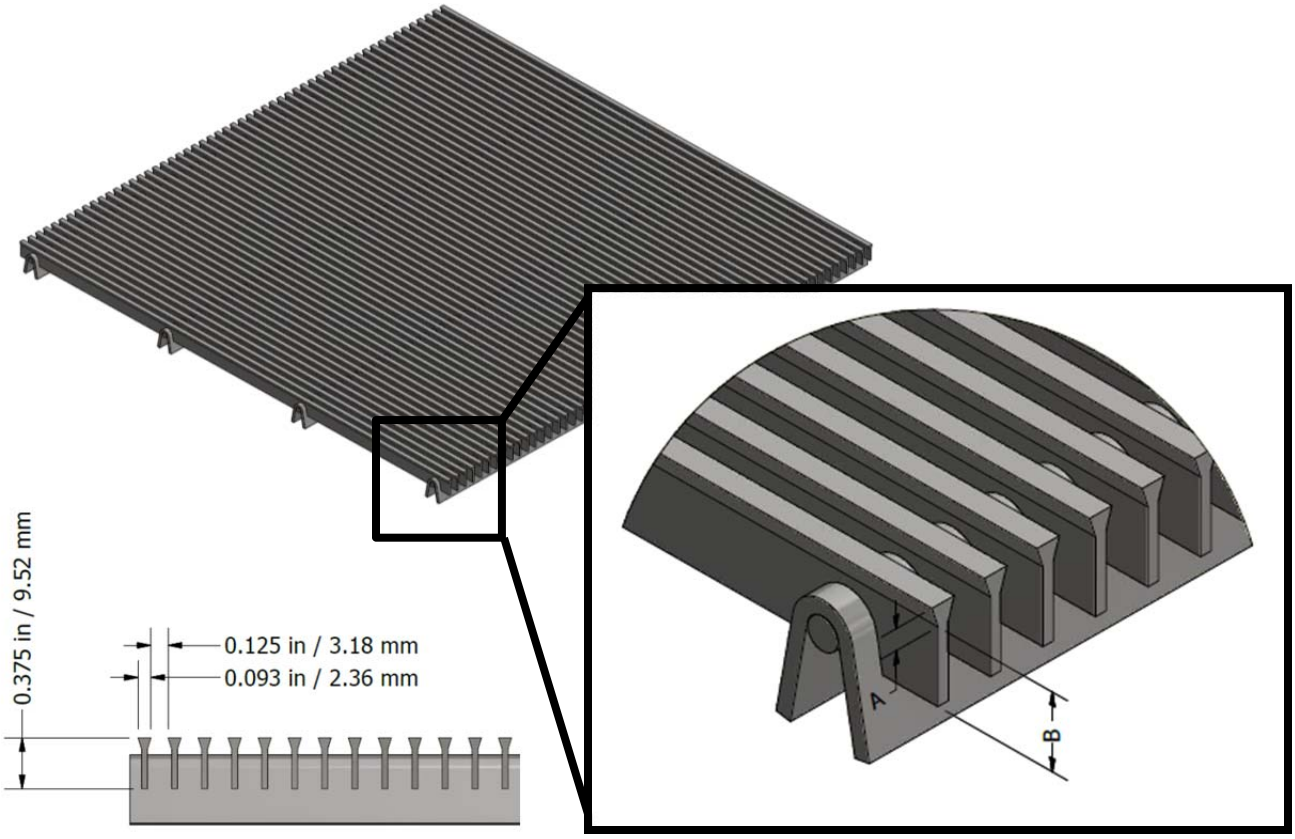

Figure 4: Profile Bar Screen

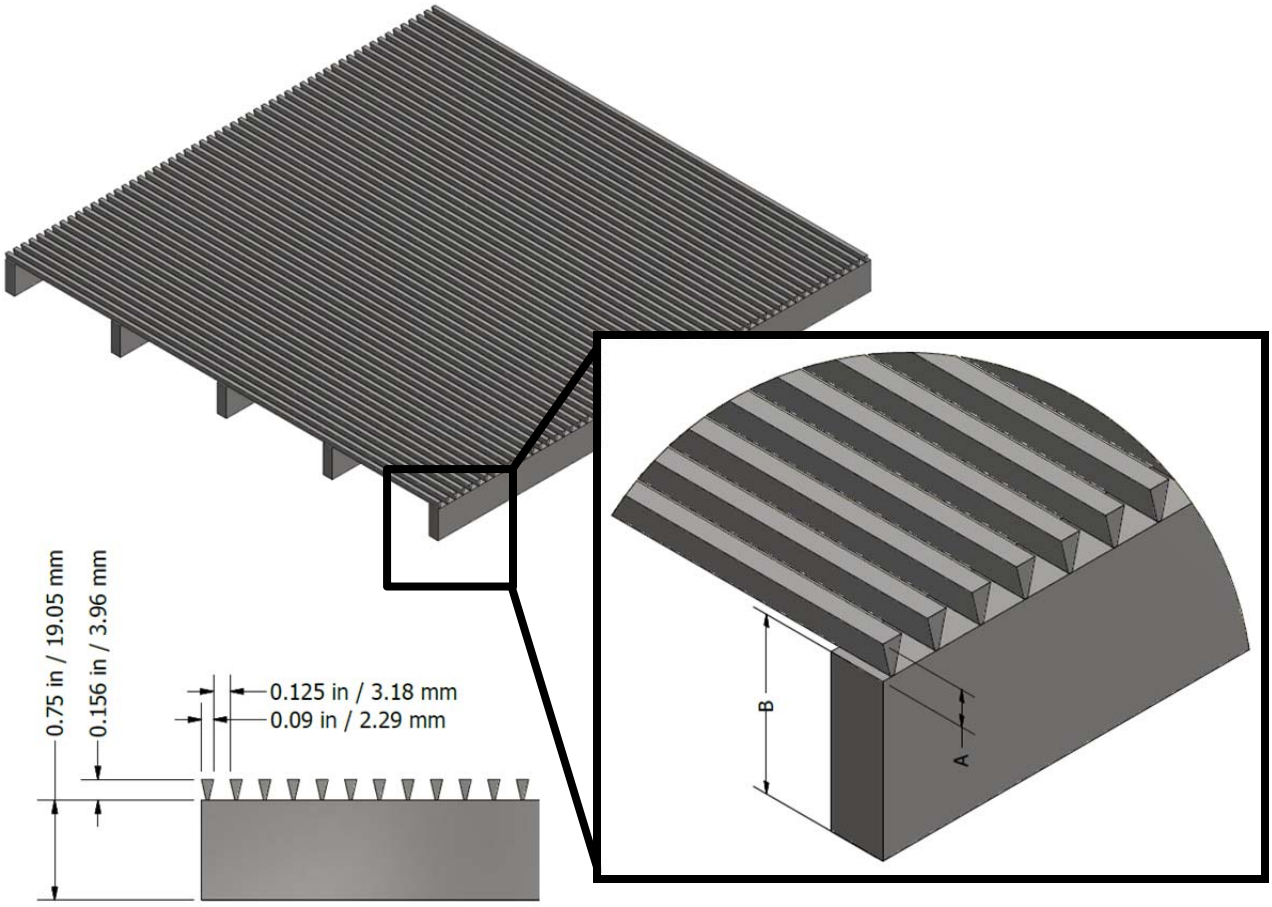

Figure 5: Wedge Wire Screen

Flow Characteristics

With any screen media that is use to filter water, the flow of water results in contraction of the flow into a small opening. The amount and duration of the contraction will result in head loss – the irreversible pressure loss of a fluid as it encounters friction due to high velocity, wall roughness, and directional changes. Head loss can be a major problem for water intake structures. If feeding a wet well or reservoir through a screen, the head loss can result in a water level change that requires the system to have considerably more elevation change between the source and the destination (larger civil costs for construction or environmental impact with lower water levels). When these reservoirs or wet wells contain pumps, the head loss might prevent the intake water from keeping up with the pumping capacity. In applications with screens attached to the end of pumps, this head loss can induce a large amount of undesirable back pressure on the pump.

By examining the detail views of figures 4 and 5, you can see that the water will encounter two different zones (A and B) when going through the screen. In the profile bar case, the water enters the smallest opening A that is 57% open area, and then quickly transitions to zone B that's about 80% open area. After zone B the water passes a flat end that will introduce turbulence to the water. The U-clips also introduce the same turbulence, but the open area is much larger after leaving zone B, so the effects are less severe. This is a similar phenomenon that can be observed on minivans driving down the highway. They are extremely dirty on

the back because their box end results in air turbulence that pulls dirt to into this low pressure area. In the case of wedge wire in figure 2, the water will see a similar zone A of 58% open area, but then it will quickly shift to zone B that's about 92% open area at the support bars. These support bars are also flat on the end like the profile bar, but the open area is so large that the turbulence effects will be much less. Also, the initial escape from zone A will result in a much smoother mixing of the water since it goes around a "V" shape that does not have a blunt edge. See figure 6 for a comparison of the specific flow around the profile bar and wedge wire.

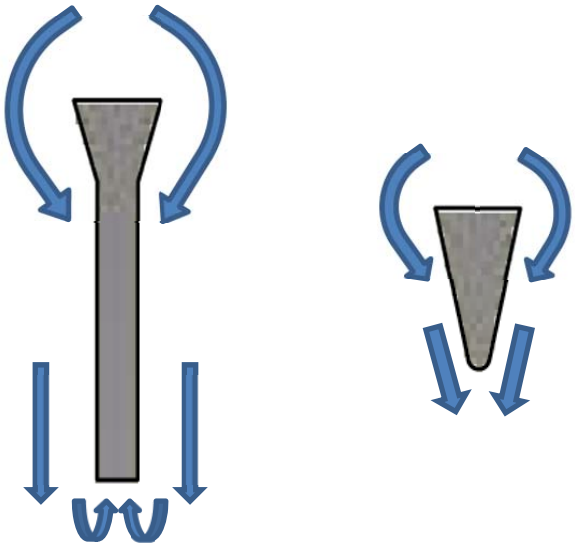

Figure 6: Flow Characteristics

Elgin performed a CFD analysis on the two representative panels in figures 4 and 5 given the same intake capacity and boundary conditions - see figures 7 and 8. The profile bar screen had 36% higher head loss than the wedge wire screen. Ultimately the head loss will not be very high on either screen on an absolute scale, but it's worth noting that wedge wire provides a clear advantage in this area with regards to head loss and turbulence. The CFD images confirm that the velocity spike that occurs through the screen wire area (zone A) is much longer in a profile bar screen when compared to wedge wire.

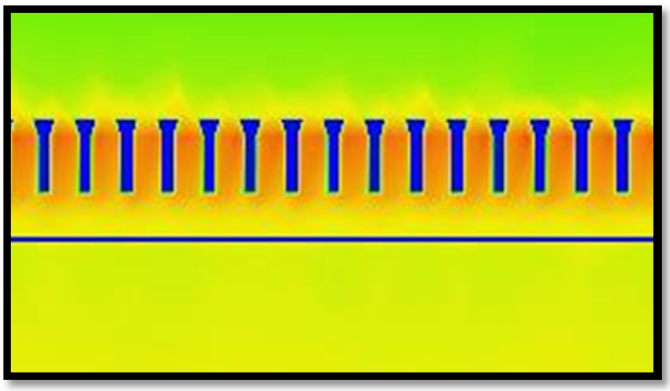

Figure 7: CFD Velocity Image - Profile Bar

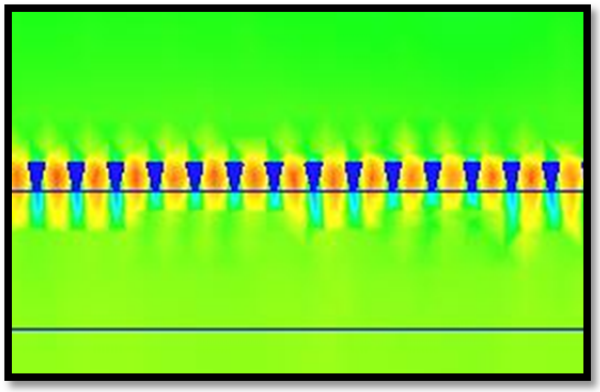

Figure 8: CFD Velocity Image - Wedge Wire

Flatness

In applications with large infiltration galleries with vertically oriented screen panels, flatness of the screen panel can be critical. When these systems include flat panels that are designed to pull in and out of the water using guide rails, having a flat panel makes the sliding within the guide system consistent and predictable.

When these systems include a brush system, the flatness can become even more critical. A profile bar screen is capable of achieving flatness down to nearly $^{1}/_{16}$ in. A wedge wire screen is capable of reaching these tolerances, but will require additional design considerations and labor during the flattening process. A typical flatness for a wedge wire screen will be closer to ⅛ in. There are a variety of brush systems available and Elgin has successfully supplied screens for such systems. It's possible that the amount of brush interference required will prevent the use of a wedge wire screen, but it doesn't seem likely with such a small difference.

Price

The price point of a profile bar is considerably higher than that of a wedge wire screen. This price difference is attributed to the amount of labor needed to fabricate, as well as the materials used for fabrication.

In a wedge wire screen from Elgin's TIG welding process, the screen wires are welded to each support rod using a continuous welding motion on a large welding machine. This machine has a fixture bar for the given wire size and pitch that will hold the wires while the operator feeds the wire down the machine, stopping to place and weld support bars at the prescribed pitch. While there is some post-process flattening, the amount of labor involved to fabricate the screen is minimal. A profile bar screen will require the operator to layout the U-clips and profile bars in such a way as to allow for the long pins to be inserted through holes in each profile bar. Since this pin will need to be fed through each hole in each profile bar, this process requires much more labor.

Material cost is likely the biggest factor in the price difference. Wedge wire screens utilize a single engineered product (the wedge wire itself) that is an extruded shape. Elgin extrudes some profiles in house to further reduce cost, but many shapes are purchased. A profile bar is not only an extruded shape, but it also has holes post drilled or punched into the material to further increase the cost. Also, the profile bar is nested into U-clips that have custom formed slots to hold the profile bar at different slot openings. Regardless of the exact cost of each screen type's components, given the example shapes in figures 4 and 5, the wedge wire screen is made up of roughly 30% engineered material by weight, whereas the profile bar portion component of the profile bar screen panel makes up about 75% of the weight (and it could be argued that nearly 100% of the weight is engineered material since the U-clips are a specialized product).

Conclusion

Profile bar screens have been promoted as the ideal choice for fish screening applications in the Pacific NW, but after further examination of the merits it's clear that a wedge wire screen can fit nearly all applications. The only specification that is inferior in a wedge wire screen is the flatness, but Elgin has not encountered a brush company that requires such a strict tolerance on flatness that makes wedge wire an invalid choice.

Not only will a wedge wire screen be able to conform to whatever approach velocity or slot opening that an application demands, but it will do so with better flow quality and at a lower price. The amount of wire/slot combinations available by Elgin and the design freedom available for the welding bars and supporting structure make it a clear choice for nearly any screening application.