Industrial Fiberglass Specialties, Inc.
521 Kiser Street
Dayton, OH 45404-1641
Tel: 937-222-9000
Fax: 937-222-9020

Designing the Support System for FRP Composite Pipe and Duct and Other Piping Materials

We are often asked by clients how far apart they can space the supports for FRP composite pipe or duct? The simple answer is - it depends.

While there are tables published that can be used as a guide, the design parameters required to determine the spacing for any type of pipe - be it carbon steel, thermoplastic, alloy, ductile iron, aluminum, or FRP composite pipe - are complex, and require detailed engineering stress analysis.

- The most important controlling criteria for determining support spacing is the pipe or duct diameter. The support spacing for ½" diameter pipe needs to be much closer than the distance between supports for 72" diameter duct. (We build FRP composite pipe and duct from 3/8" diameter through 168" diameter).

- The strength or stiffness as a beam, between supports increases by the fourth power of the radius of the pipe. Sometimes, when the spacing between supports is dictated by the location of the structural steel - you can span that additional distance by using a slightly larger diameter pipe or duct.

- Another controlling criteria of support spacing is the application or service. The support spacings can be much further apart for duct than they would be for a liquid piping system - size for size. Even for a liquid piping system - the specific gravity of the liquid needs to be considered in designing the supports and support spacing. Support spacing needs to be closer for pipe handling a liquid having a specific gravity of 1.22 versus a specific gravity of 1.0.

- The operating temperatures (including peak upset temperatures) can also control the support spacing for FRP composite pipe. The flexural modulus for FRP composite pipe or duct operating at 100°F is significantly different than for the same laminate construction when operating at 250°F.

- If the pipe or duct is going to be installed outdoors, wind, snow and ice loads are important design criteria that need to be calculated. These loads are additive to the internal liquid weights.

- One of the many benefits of FRP composite pipe is that it can be made and provided in a wide range of wall thicknesses. Materials like PVC pipe are typically only provided in two thicknesses - Schedule 40 and Schedule 80. But, for example, 24" diameter FRP composite pipe (or duct) can be made from as thin as 0.12" wall thickness - all the way through super wall pipe having a thickness of 1-1/2", or even heavier. The support spacing would have to be closer for the thinner walled pipes.

  One technique sometimes used when the support spacings are fixed by spacing of the existing structural support steel - is to use a heavier wall pipe.

- Another of the benefits of FRP composite pipe is that the type of laminate construction can be varied to meet the specific design considerations. FRP composite pipe or duct can be contact molded - where the wall has equal physical properties in all directions (axial and hoop). Filament wound FRP composite pipe or duct can be made varying the wind angle. The wind angle greatly influences the axial and hoop strength properties of the pipe or duct.

  The support spacing for pipe or duct wound at 75° (to the axis) would require entirely different support spacing compared to pipe or duct wound at a 45° angle. Again, the wind angle can be varied to meet specific existing support spacings - balancing the wind angle with internal pressure and vacuum considerations.

- The resin matrix used for the FRP composite pipe or duct also has an influence on the maximum support spacing. Still another example of the benefits of FRP composite pipe is that it can be made with resins that are as flexible and tough as polyethylene pipe; or a resin system that has a lower tensile elongation - but superior corrosion resistance and high temperature properties.

  Just as with polyethylene pipe, (which requires very close support spacings) the more flexible FRP composite pipe or duct would have different support span requirements when compared to the higher temperature and "stiffer" resin formulations.

- In the typical piping installation - where there are elbows, flanges, tees, laterals, reducers, valves, and pump connection, - the support spacing is determined by where the supports need to be located to handle vibration, pump start up, water hammer, opening and closing of valves, and anchoring the thrust in changes in piping direction. These locations, that are mandatory for support, guides and anchors, override an arbitrary maximum support spacing, as may be determined from the other design parameters detailed above. In those cases it may also be mandatory to add additional structural supporting steel for the supports at those key support locations.

- In the real world often the spans or distances between the supporting structural steel, or the support spacing of the steel of the pipe racks, will establish the span distances for the FRP composite pipe or duct. In this situation you are working with the existing fixed span requirements. The pipe and duct design parameters will be varied to meet that span, without having to add additional or supplementary structural steel.

  An allowable maximum pipe or duct deflection between supports is determined. This deflection is usually established in a range between 1/120th to 1/360th of the span. The design parameters will be "adjusted" to keep the pipe or duct deflection within that range.

- The type of supports, as determined by a stress analysis program such as Algor's PipePak, will also have a direct bearing on the maximum support spacing. In many cases the type of support (anchor, guide, slide, etc.) must first be determined for each support location and piping system node - before the actual spacing of the supports can be determined.

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So what is the answer to support spacing for FRP composite pipe (or for any piping material)? The first step is to provide a complete systems isometric drawing of the entire piping system. Then the design engineer needs to use a stress analysis (FEA) program; such as Algor's PipePak or Caesar, to run a complete design analysis for the entire piping or duct system. This stress analysis is even important for straight long runs of pipe - where thermal and pressure expansion considerations must be considered.

We, and other pipe manufacturers, have prepared tables by pipe diameters and specific pressure rated pipe - showing the maximum support spacing. However, we have great reluctance in providing these "tables" to engineers. We are afraid that they will be accepted as "gospel", and used in piping and duct systems, in lieu of doing a full and proper engineering analysis.

Our strong recommendation is to properly design the piping support system - using the appropriate engineering software. Select from the engineering analysis the specific support locations, support span spacings, and type of supports to be used at each location. A part of that engineering analysis will also be the determination of where shear collars or anchors are to be employed, and the location and style of saddle type wear pads to be used.