

REINFORCEMENT OF FITTINGS

Tees, crosses, laterals, wyes, headers, or other fittings that provide means of dividing or uniting flow in pipelines have less resistance to internal pressure than straight pipe of the same wall thickness and size. This is because a portion of the side wall of the pipe in these fittings is removed to allow for the branching pipe. Also, there are longitudinal stresses in the throat of unrestrained elbows as a result of distortion or unbalanced hydrostatic pressure.

For ordinary waterworks installations, the wall thickness of the pipe commonly used is much greater than pressure conditions require. Consequently, the lowered safety factor of fittings having the same wall thickness as the straight pipe still leaves adequate strength in most cases, and reinforcing may be unnecessary. If the pipe is operating at or near maximum design pressure, however, the strength of the fittings should be investigated, and the proper reinforcement or extra wall thickness provided.

Fittings may be reinforced in various ways for resistance to internal pressure. Typical fitting reinforcements are collars, wrappers, and crotch plates. The design stress in the reinforcement should not be greater than the hoop stress used in the design of the pipe.

The type of reinforcement* can be determined by the magnitude of the pressure-diameter value (PDV) and the ratio of the branch diameter to the main pipe diameter (d/D). The PDV is calculated:

$$PDV = \frac{Pd^2}{D \sin^2 \Delta} \quad (13-1)$$

Where:

P = design pressure, in psi

d = branch outside diameter, in in.

D = main pipe outside diameter, in in.

Δ = branch diameter angle of deflection

For PDV values greater than 6,000, the outlet reinforcement should consist of a crotch plate designed in accordance with the method described in the Crotch-Plate (Wye-Branch) Design section. For PDV values less than 6,000, the outlet reinforcement may be either a wrapper or collar, depending on the ratio of the outlet diameter to the main pipe diameter d/D . For a d/D ratio greater than 0.7, a wrapper plate should be used; for a d/D ratio less than 0.7, either a collar or a wrapper plate may be used. The ratio d/D does not include the $\sin \Delta$ as in the PDV determination because the circumferential dimensions are the controlling factor. Wrappers may be substituted for collars, and crotch plates may be substituted for wrappers or collars.

*Reinforcement for certain crosses, wyes, or double laterals may require additional analyses beyond the criteria discussed in this standard.

Table 13-2 Recommended reinforcement type*

PDV	d/D	M Factor	Reinforcement Type
>6,000	all	—	Crotch Plate
4,000–6,000	>0.7	0.00025 PDV	Wrapper
<4,000	>0.7	1.0	Wrapper
4,000–6,000	≤0.7	0.00025 PDV	Collar
<4,000	≤0.7	1.0	Collar

* These reinforcements are for resistance to internal pressure. They should be checked for their ability to resist external loads.

Wrappers and collars are designed similar to the method described in Sec. VIII of the ASME Boiler and Pressure Vessel Code. This code provides that the cross-sectional area of the removed steel at the branch is replaced in the form of a wrapper or collar. In addition to the ASME requirements, when the PDV ranges between 4,000 and 6,000, the cross-sectional area of the replaced steel should be multiplied by an *M* factor of 0.00025 times the PDV. Figure 13-3 shows the reinforcement of wrapper and collar openings for welded steel pipe, and Table 13-2 lists a summary of recommended reinforcement types. The minimum steel thickness for wrappers and collars shall be 12 gauge (0.1046 in. [2.65 mm]).

In determining the required steel replacement, credit should be given to any thickness of material in the main-line pipe in excess of that required for internal pressure, and to the area of the material in the wall of the branch outlet to the allowable distance from the collar or wrapper ($2.5t_y$). Weld areas should not be considered in the design. The overall width of the collar or wrapper should not be less than $1.67d/\sin \Delta$ and should not exceed $2.0d/\sin \Delta$. This width range produces a minimum edge width of $0.33d/\sin \Delta$. Collar edge widths in the circumferential direction should not be less than the longitudinal edge width.