NCICLB Exam - Thrust Blocking v24.10.1

Excerpt from *Designing, Operating, and Maintaining Piping Systems Using PVC Fittings - A of Design Guidelines and Precautions*, by Ron D. Bliesner, Keller-Bliesner Engineering, Feb. 1987, pages 12 & 13.

Water under pressure exerts thrust forces in piping systems at: changes in pipe size or direction, dead ends, valves, and hydrants. The size, shape and type of thrust blocking required depends on the maximum system pressure, pipe size, appurtenance size, type of fitting, line profile and soil type.

The design of thrust blocking requires knowledge of the thrust generated and the bearing strength of the soil against which the thrust block will be placed. Thrusts developed per 100 psi of line pressure for various pipe sizes and fitting types are presented in Table 5. These values can be used in conjunction with the soil bearing strength data presented in Table 6 to calculate thrust block sizes.

TABLE 5. Thrust developed per 100 psi of line pressure for various pipe sizes and fitting configurations.

Pipe Size (inch)	**Fitting 90° Elbow** (lbs. force)	**Fitting 45° Elbow** (lbs. force)	**Valves, Tees, Dead Ends** (lbs. force)
1½"	300	200	200
2	500	300	400
3	1,000	---	800
4	1,800	1,100	1,300
6	4,000	2,300	2,900
8	7,200	4,100	5,100
10	11,200	6,300	7,900
12	16,000	9,100	11,300

TABLE 6. Estimated bearing strength of typical soils

Soil Type	**Bearing Strength** Lbs/ft^2
Much, Peat, etc.	0
Soft Clay	500
Silt loam	750
Sand	1,000
Sand and gravel	1,500
Sand and Gravel with Clay	2,000
Sand and Gravel Cemented with Clay	4,000
Hard pan	5,000

It is a fairly common practice to install thrust blocks at the locations discussed above. However, several precautions are necessary to assure that the thrust blocks are adequate. To be effective, a thrust block must:1) be placed against undisturbed or fully compacted earth; 2) contact the fitting over a sufficiently large area so as not to create point stresses on the fitting; and 3) have sufficient area on the soil side to restrain the thrust without exceeding the bearing strength of the soil. Some typical examples of thrust block installations are shown in Figure 11.

To illustrate the technique for designing thrust blocks, consider the following example:

Given:

A 6-inch PVC 90 elbow operated at 100 psi maximum pressure is installed in a loam soil which is between a sand and a soft clay.

Analysis:

From Table 5, the thrust which must be supported by the soil equals 4,000 lbs.

From Table 6, the bearing strength of the soil is about 750 lbs/ft2.

Therefore, the required thrust block contact area must be:

contact area = 4,000 / 750 = 5.3 square feet

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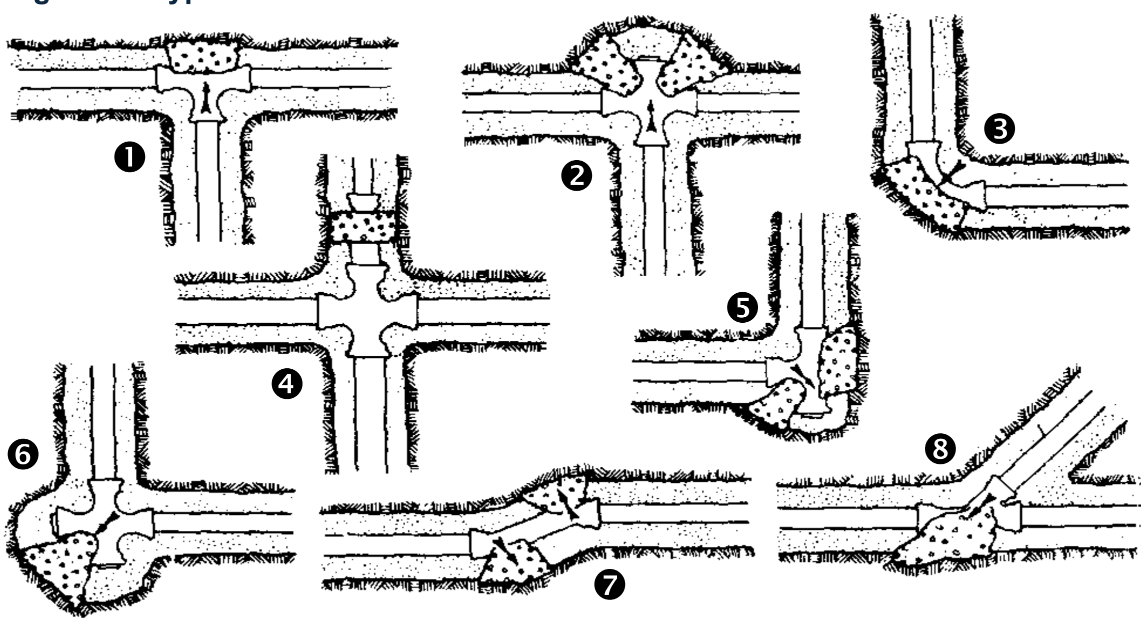
Temperature Expansion Considerations

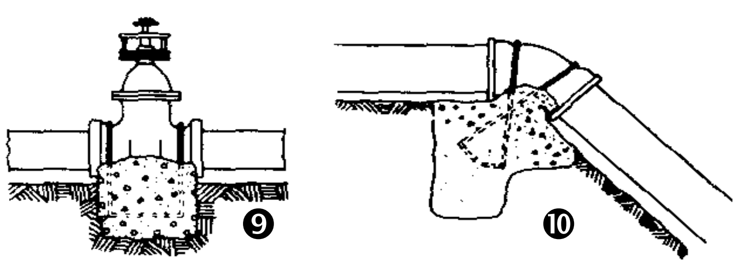
All pipe materials expand and contract with changes in temperature and this dimensional change must be considered in the design and installation of piping systems. As a general rule, a 10°F change in temperature will cause PVC pipe to expand or contract 3/8 in for every 100 ft of length. For example, a 1,000-foot pipeline installed in the summer when the ambient temperature is 90°F would shrink about 20 inches if the soil cooled to 40°F in the winter. This change in length must be accommodated or severe damage to the pipe and fittings will result.

There are several methods for dealing with thermal expansion and contraction. The most common today, especially for 4-inch or larger diameter pipe, is the use of gasket joints. A 3-inch or smaller diameter pipe can be snaked in the trench to accommodate the thermal expansion. For larger diameter pipe with solvent weld joints, offset or expansion joints must be used to accommodate length change.

Figure 11. Typical thrust block installations.



If thrusts, due to high pressure, are expected, anchor valves as below. At vertical bends, anchor to resist outward thrusts.



1. Thru line connection, tee
2. Thru line connection, cross used as tee
3. Direction change, elbow
4. Change line size, reducer
5. Direction change, tee used as elbow
6. Direction change, cross used as elbow
7. Direction change
8. Thru line connection, wye
9. Valve anchor
10. Direction change vertical, bend anchor