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Report No.17

Report on Loss Coefficients of Valves and Fittings for Asbestos Cement Pipes

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Date: 1.6.60

Introduction

Tests on fittings for use with asbestos cement pipes were undertaken at the Water Research Laboratory on behalf of James Hardie Pty Ltd, Sydney. The fittings consisted of cast iron bends, with deflection angles of 90°, 45° and 22½°, tees, cross junctions and sleeves for 4 in. and 6 in. pipes and asbestos cement bends with one and two mitre joints, both with deflection angles of 90°, for 4 in. pipes. The fittings were tested separately.

Method of Test

The fitting was installed in an asbestos cement pipeline of corresponding nominal size, with rubber ring joints. In order to detect the overall loss produced by the fitting, that is, the local loss plus the additional resistance losses due to non-uniformity of flow downstream of the fitting, head loss readings were taken over a length of twenty feet upstream of the fitting and over a length extending from one foot upstream to 19 feet downstream of the fitting. The difference between these two head losses was taken as the loss H_L due to the fitting.

The flow rate was determined by means of an orifice plate and differential manometer installed well upstream of the test lengths, and the flow rate was controlled with a valve downstream of the test lengths.

The tees and cross junctions were tested for straight through flows and for flows around the 90° angles, with the other openings blanked off.

The loss coefficient K is defined, from the equation $H_L = K \frac{V^2}{2g}$

$$\text{as } K = \frac{2gH_L A^2}{Q^2}$$

where A is the actual area of the asbestos cement pipe used. For the 4 in. fittings, the actual pipe diameter was in., and for the 6 in. fittings, in.

The mean velocities of flow ranged between 3 and 12 fps and the water temperature was 60°F.

3. Results

The values of K decreased with increase in velocity, the decrease being of the order of 10 per cent over the range from 3 to 12 fps. Typical variations are indicated in Fig 1 which shows the curves for some of the 4 in. fittings.

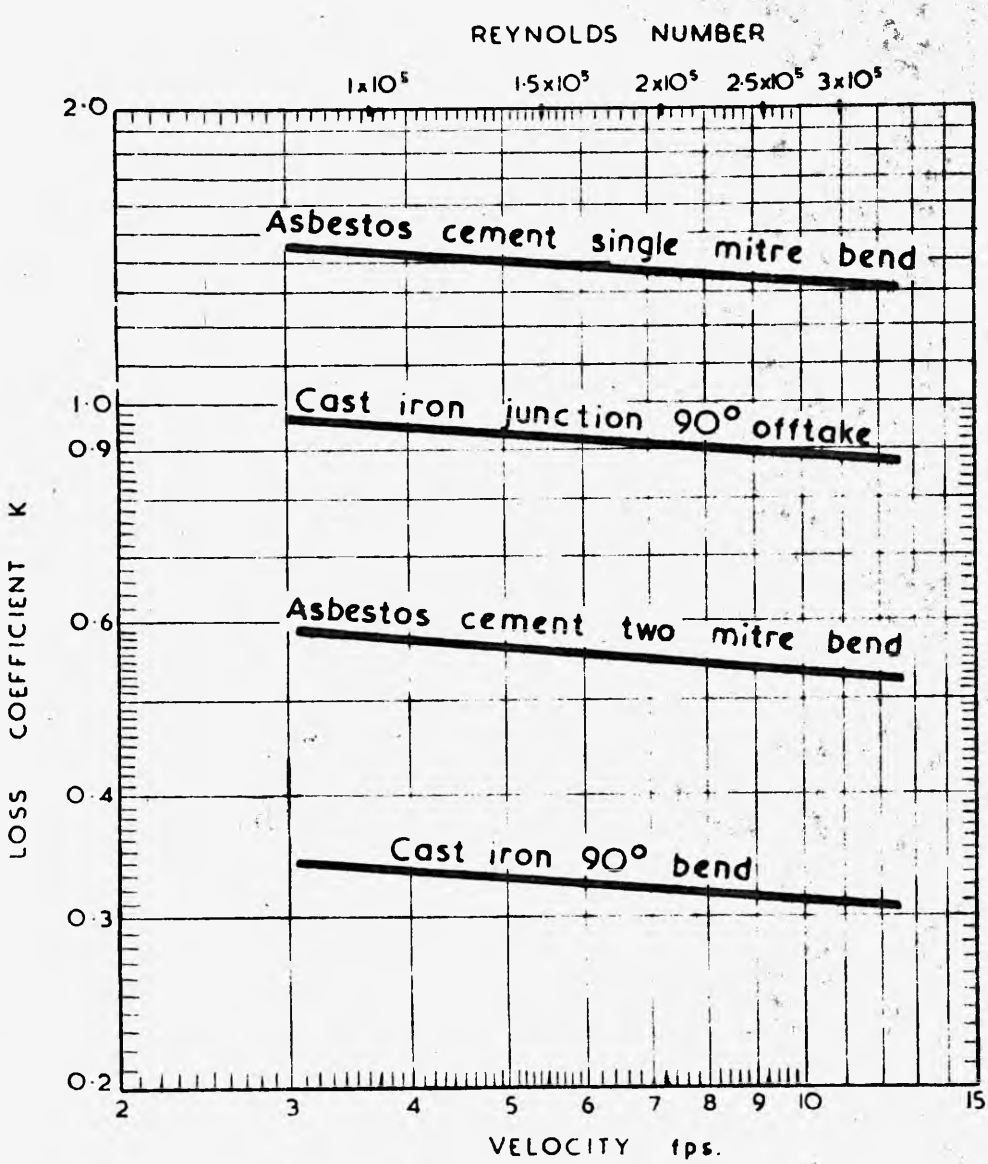

Fig 1. Loss coefficients of 4 in. fittings for asbestos cement pipes.

Mean values of K for each fitting, over the range of test velocities, are shown in Table I. These values correspond approximately to the values for a velocity of 7.5 fps.

TABLE I

Mean Values of Loss Coefficient K
For pipe velocities from 3 to 12 fps

Fitting	4 in. dia	6 in. dia
1. C.I. Bends		
90° (1/4)	0.32	0.34
45° (1/8)	0.24	0.25
22½ (1/16)	0.17	0.18
2. A.S. Bends		
90° single mitre	1.25	-
90° two mitre	0.55	-
3. C.I. Tees		
Straight through	0.15	0.15
90° offtake	0.90	0.90
4. C.I. Junctions		
Straight through	0.15	0.15
90° offtake	0.90	0.90
5. C.I. Valve		
fully open	0.16	0.16

4. Comments

The head loss due to a fitting depends primarily upon its geometric form and to a lesser extent upon the roughness of its inner surface, the nature of the joints and the Reynolds Number of the flow. Other investigators, notably Beij (Ref. 1) and Hofman (Ref 2) have found that in rough pipes, there is little variation of the loss coefficient with Reynolds Number.

The effect of the geometric form is to produce turbulence losses resulting from separation of the flow from the walls at changes in wall alignment and from eddy motion set up by secondary flows.

It is difficult to reconcile the divergent data available in the literature. Efforts have been made to obtain general design information on losses in fittings. Even in the present tests appreciable differences were obtained with tests on fittings which were supposedly identical but which on examination were found to differ in dimensions and in the quality of surface finish.

For a 90° bend, the results of Beij and of Hofman are commonly quoted. A comparison of figures based on their work with those obtained in the present tests is shown below.

Pipe diameter	4"	6"
Ratio $\frac{\text{bend radius (R)}}{\text{pipe dia (D)}}$	2.25	1.60
Beij (smooth pipes k = 0.0003 ft)	0.18	0.22
Hofman (large, rough conduits)	0.29	0.32
Present tests (cast iron, k = 0.001 ft)	0.32	0.34

It would appear that the values proposed by Hofman are in fair agreement with those of the present tests. For pipe sizes other than 4 in. and 6 in., it is advisable to estimate K from the Hofman chart for rough pipes, rather than to adopt the present test values. The Hofman charts for smooth and rough pipes are reproduced on p.421 of "Engineering Hydraulics" (H.Rouse, published by John Wiley and Sons 1950).

For a single mitre bend, a commonly quoted value for the loss coefficient is 1.1, whereas the present test gave a value of 1.35, a figure which includes the effect of losses due to the joints. The two mitre bend value of 0.55 indicates a significant reduction in comparison with that for the single mitre.

For gate valves fully open the loss coefficients are a little higher than values quoted in standard texts (e.g. King "Handbook of Hydraulics").

5. Conclusion

For normal design purposes it is desirable that loss figures be [illegible] the mean range of pipe diameters and velocity. The following figures are quoted on safe values for 4 in. and 6 in. [illegible] The losses given provided that the geometrical [illegible] of the fittings do not differ appreciably from those of the 4 in. and 6 in. fittings.

TABLE V

Loss Coefficients for 4 in. and 6 in. Fittings
[illegible] Asbestos Cement Pipes.

Fitting	K	Equiv. Length of Asbestos Cement Pipe (Velocity 7.5 ft/s)
1. [illegible] Bends		
[illegible]°	0.34	11
[illegible]°	0.25	8
[illegible]°	0.20	7
2. [illegible] Bends		
90° Single Mitre	1.40	45
90° Two Mitre	0.60	20
3. C.I. Tees and Junctions		
[illegible]	0.15	5
[illegible]	0.90	30
4. C.I. 4 to 6 Taper		
Fully open	0.16	5

References

1. Zoll, K.H. "Pressure Losses for Fluid Flow in 90° Pipe Bends" J. Research Nat. Bureau Standards Vol. 21st July 1938.

2. Hofmann, A. "Loss in 90° Bends" Publication of the Hydraulic Institute of Munich T.H., Munich 1929.